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FIRE INSURANCE AND ELECTRICAL ENGINEERS.

THE responsibilities and anxieties of electric light contractors increase quite as rapidly as the advance of knowledge. Not only has the electrical engineer to note the immense progress around him and keep step with it, but he has to acquaint himself with amended Acts of Parliament, general laws, and special laws varying with localities, and he also has to keep alive to increasing demands on the part of insurance offices and other contingencies. What with laws, science, art, fashion, whims and fancies, not to mention obstinacy, the modern electrician's bed is not one of roses. A new danger, we are informed on good authority, stares him in the face ; a danger not quite unknown to gas companies, but one of which we should be fully aware lest surprise overtakes us at an unguarded moment. It involves a legal question of great subtlety which should be very clearly defined, and the sooner the better. We are told that Counsel is already being engaged for the purpose of interpreting all the points at issue. The question, in the abstract is, whether electric light contractors can be made responsible for any loss occasioned by fire, in the event of the conflagration being traced to the electric current, and provided that it can be shown that the rules of a given fire office have not been adhered to "to the letter." Now these rules for the prevention of fire risks are very broad and drawn up in general terms, for it would be impossible to provide for every emergency which might arise, and it was never intended that they should become a specification to which contractors must work. Even specifications would not answer the purpose for more than a few months' time considering the improvements which are constantly being made in electric light fittings, and an article which may to-day be termed sufficiently safe within the said rules, might possibly be rejected to-morrow as unsuitable by the fire office inspectors. We have had repeated complaints on the part of contractors against inspectors—who are virtually the interpreters of printed regulations—which showed that certain switches, cut-outs and the like, had been passed as within the requirements of an insurance company, and identical articles in a subsequent case were rejected by the self-same man. At times it has been hinted that these inspectors have but a scant knowledge of the subject, that they are not competent to dictate in matters electrical, and that they frequently reject things without giving a sufficient scientific reason, and recommend others of worse construction. These uncertainties have driven some of the contractors almost to despair and caused them to look upon fire office inspectors as their natural enemies.

We do not deny that England has enjoyed comparative immunity from fires, and we think that this is due as much to the stringent demands of fire offices, the Phœnix in particular, as to intentional good workmanship. There may sometimes have been in these rules, or in their application, incongruities and hardships, but contractors must not forget that the inspector's position is one of great responsibility both to his company and to the public, and that he must insist upon the best material being used for specific purposes, and as there are so many changes in quality and construction of electric appliances, it will and must happen that the inspector can, at his discretion, pass as good one day what, owing to improvements, he may reject in the near future.

Electricity, under ordinary circumstances, is the safest illuminant, yet there are contingencies in which the risk of fire is greater than with other methods of producing light. The escape of gas can be detected by its smell, a lighted match is a visible thing, and generally, internal fires in a house are traceable to and caused by the inhabitants. With electricity it is otherwise, it is not so apparent to our senses, and a fire may occur in an empty house through defective insulation.

Such being the case, we must admit that stringent rules are wholesome as long as human nature pervades electrical engineers as it does other people, that is, they

desire to make as much profit as possible, and so long as the installation does its work, not to think of future contingencies. Under the new aspect hinted at the beginning of this article, it will be apparent that contractors have not only to think of the credit or discredit which their work may throw upon the industry as a whole but, now that the question of their ultimate responsibility may prominently be brought to their notice, also of their legal liabilities.

A Discovery.

A CONTEMPORARY, in its last issue, appears to have discovered a mare's nest. In referring to a letter which appeared in a previous number, our contemporary states that "the writer of the letter draws from the fact that a slowly alternating current is more painful than one which alternates more rapidly, an inference different from that to which Mr. Newman Lawrence seems to incline." This is a wrong conclusion on the part of the paper in question. In the discussion on their lecture, Dr. Harries stated "that the greater the frequency the less unpleasant a given current becomes," whilst Mr. Lawrence said "that from greater frequencies he would expect less effect." Do not both these statements imply that the lower the number of alternations the more painful is a given current?

The Edison-Lalande Battery.

A GOOD deal of attention has recently been paid to the Lalande battery by Mr. Edison, and it appears that a good practical form has now been devised. The elements of the battery, as is well known, are zinc and oxide of copper in an exciting solution of caustic potash. The oxide is compressed into solid blocks held in position in the cells by a light frame of sheet copper. A cell $11\frac{1}{4}$ inches high by $5\frac{3}{8}$ inches diameter has an internal resistance of ·05 ohm and a working capacity of 100 ampère hours. The one defect of the cell is its low electromotive force, which, initially, does not exceed ·9 volt, and when heavily worked falls to ·7 volt. On short circuit the cell is capable of delivering 14 ampères, and it is stated that there is practically no local action. The result of a test showed that with a mean current of 2·76 ampères and a total output of 298 ampère hours the loss by local action was only 6 grammes in 1,450, or a little over ·4 per cent. The test extended over 108 hours. In spite of the low E.M.F. there appear some qualities in the cells which render them very suitable for certain classes of work.

High Tension Limited.

THE opinions of certain well-known English electrical engineers on high tension underground circuits, which we publish in another portion of this issue, are worth careful study even if they have not the advantage of being the result of practical experience. Not the least significant of these is expressed in the answers to Question 1, and if anything were wanted to support our consistent protests against the feasibility of the Deptford scheme, we have here ample material to argue from. Probably the directors of the London Electric Supply Corporation will now begin to feel that those technical journals which have spoken in such favourable terms of Mr. Ferranti's 10,000 volt scheme did not represent the views of those who had had some little experience of insulating bodies long before that young gentleman was ever heard of. So far as this paper is concerned, we have every reason to feel satisfied with the comments we have from time to time made upon the Deptford installation, for they are more than justified by the utterances of such men as Sir William Thomson, Dr. Hopkinson, Prof. Forbes and the others.

Postal Telegraphs and Electric Lighting.

THE second paragraph of Mr. Preece', reply to Question 4, is in that gentleman's most attractive and airy styles although we fail to see that his 37 years' experience with 30,000 miles of underground telegraph and telephone conductors has any direct bearing upon the safety of the high tension alternating transformer system. Nevertheless, the Americans will doubtless be profoundly impressed by Mr. Preece's unique answer even if its continuity seems a little involved. As Jack Bunsby used to say, "the bearing of this observation lays in the application on it."

One Way of Looking at it.

PROF. GEORGE FORBES also seems to have a very extraordinary notion as to the proper comparison of the relative uses of low and high pressure systems. That the best idea can be gained by the means he adopts is not a fact, for the London Electric Supply Corporation overshadows all the rest so far as money is concerned, but what has it got to show for its enormous capital, authorised or paid up? Comparing the paid up capital of the rival methods does not necessarily show the amount of *bonâ fide* business done by the respective companies, for money may be expended in the most lavish manner without any satisfactory results to either shareholders or the public. That the low pressure systems can forge ahead with only 8 per cent. of their capital called up seems to us to be greatly to their credit, but Prof. Forbes appears to be under the impression that money spent necessarily means solid business. Our trans-atlantic cousins, however, are shrewd enough to form their own ideas on this point.

Generalities.

PERHAPS the greatest advantage to be derived from the opinions of the English experts who have been inveigled into giving publicity to opinions which have little foundation in fact, will fall upon the India-Rubber and Gutta-Percha Company. The testimonials to the excellence of their insulated conductors will doubtless bear fruit, and deservedly so, but we wish the questions had been addressed to gentlemen who have been practically connected with installation work. We might then have had facts given to us instead of mere surmises, and even now perhaps Mr. Musgrave Heaphy might be prevailed upon to give his experiences on all the points at issue.

Measuring Instruments.

IN a recent number of *L'Electricien* the results of experiments made on voltmeters and ampèremeters to verify their correctness from time to time, are given; these results are instructive and do not inspire one with confidence in these instruments, the changes being as much as 12 to 14 per cent. in the course of a year. The instruments experimented on were of the Deprez-Carpentier type, in which the movable portion consists

of a soft iron paddle placed in a solenoid. The directive force was a powerful horseshoe magnet, and the sensibility of the instrument was such, that a movement of 1 to 2 per cent. could be easily detected.

The Explosion at Bell Rock.

THE details of the explosion at the Bell Rock Lighthouse, as given in our "Notes" columns, are interesting as giving the cause of the explosion, and as showing that where electrical arrangements are in operation, more than usually careful instructions should be given where the *employés* are unskilled in "electrics." The direct cause seems to have been the want of an automatic or other switch for cutting out the magneto until the explosive was in its proper firing position.

Proposed Electrical Club.

FROM time to time spasmodic efforts have been made to form a club amongst electrical engineers, but hitherto they have met with but little favour. The latest attempt in this direction—one which, from its half-private nature, we should probably have refrained from noticing, had not a contemporary referred to it last week—is fathered by three gentlemen who represent more or less fully the commercial and technical sides of the electrical industry. A strong feeling is said to be existent among numerous gentlemen in favour of taking action by which members of the profession may have opportunities of meeting each other in a social way with the advantages offered by a club house. The scheme now under consideration is to affiliate a chosen number of electrical men with the Whitehall Club which is the representative house of the civil and mechanical engineering professions, and this being the case, say the promoters, it is a centre of interests kindred in their nature with those of electrical engineering. The *Electrical Engineer* considers that although the Institution and the Electro-Harmonic Society serve an admirable purpose in allowing disjointed conversations and hand shakings, yet neither of them provides for that desire for intimate social knowledge and contact which the electrical clubs of the States provide for their members. This we admit, but does the latest proposal in any way help us towards the goal which so many have tried to reach? To limit electricians in town to 60 will not by any manner of means make the electrical section of the Whitehall Club a representative body, but will lead simply to the formation of a little business *coterie*, good enough in its way, no doubt, but of service only to the favoured candidates privately invited to become members. It is argued that the formation of an entirely new club is impossible on account of the limitations of numbers, but is this really the case? The Institution now possesses a large body of members, and there are still other engineers of repute who hold aloof from it, so that if the matter were taken up energetically and the terms of subscription not put at too formidable a figure, we imagine that the nucleus of a sound club might be instituted without very great difficulty. It is all very well to say that the interests of civil, mechanical, and electrical engineers are identical, but the day will arrive when the lion lies down with the lamb, before individual members, or even the councils of these bodies, are taught to accept such a doctrine. Already suggestions have been put forward to amalgamate the interests of all three societies, but the notion found favour only in the quarter from whence it emanated. In social matters, of course, a different feeling may prevail, and there is no reason why the civil engineer and the electrician should not together enjoy the privileges of a clubhouse; but we think the promoters of the New Electrical Club, Limited, would have served a better purpose had they tried to form a powerful combination of engineers and electricians generally, with the idea of forming a special body amongst themselves. It is possible that then the engineering members of the Whitehall and other clubs might have seceded and joined the new one *en masse*. As the proposal stands we cannot but think that its inception, its development, and the terms of membership now placed before the electrical world will not meet with that reception which the promoters seem to anticipate, for we fear very greatly that they will be simply credited with an attempt to form a clique.

Nomenclature.

THE search for a word to express electric propulsion pursues its wild and erratic course. Since all endeavours to capture this etymological will-o'-the-wisp seem to have failed, we would recommend Lord Bury to appeal as a *dernier resort* to the originators of "Volapuk." Some of our readers have probably already laughed over the following verses, from the *Scots Observer*, but we think them good enough to bear reproduction:—

THE PASSIONATE ELECTRICIAN.

(*Inscribed to Lord Bury.*)

Sweet, shall we volt it? Dearest, shall we ohm
Our wingèd way across the ocean foam?
Or were it fairer to electricize
(Or electrate) our path to happier skies?
What's in a name when all roads lead to Rome?
Fairest and rarest under heaven's high dome,
O shall we squirm, or Watt, or electrome?
Or, if you feel you'd rather not volize,
Sweet, shall we volt?

Heart of my heart, no fond and frolic tome
But the grave *Times*, that moral metronome,
Bids us coulomb, or spark, or motorize,
And now I think of it the blue day dies;
'Tis time, 'tis time, that we were moting home—
Sweet, shall we volt?

As it is only reasonable that our subscribers should fully participate in all the advantages of the most recent developments in scientific phraseology, we recapitulate some of the examples of words suggested to Lord Bury, with the remark that most of them would, at first sight, appear to have been taken from the "Hunting of the Snark."

Motor,	Amber,	Watt,
Moto,	Spark,	Motor,
Electrise,	Gleam,	Dynamo,
Electricise,	Flash,	Electr,
Electrate,	Coulomb,	Volt,
Tric,	Volice,	Ohm,
Speed,	Volize,	Bury,
Squirm,		
To voltaze,	To galve,	To simmer,
To volve,	To navigate,	To streak,
To electripede,	To sail,	To pelt,
To electro,	To electricit,	To jet,
To lectro,	To vect,	To hum,
To dyno,	To current,	To bolt,
To morse,	To blitz,	To electroforce,
To teleway,	To flit,	To dyne,
To fare,	To burr,	To trize,
To fluid,	To buzz,	To locre,
To stream,		

ON THE EXCITEMENT OF ELECTRICITY AND HEAT IN ELECTROLYTES.

By MAX PLANCK (*Annalen der Physikn und Chemie*).

(*Continued from page* 371.)

Section 3.—*Determination of the Potential Function.*

We will show that by means of the differential equation (q) the potential function, ϕ, is determined in the whole interior of the solution all but an additive constant if we know the composition of the solution (therefore U and V), and, in addition, what currents, if any, enter the solution from without. The latter is the case if the value of the specific intensity of the current, J_ν, is given for every element of the surface, as we will therefore assume. The values of J_ν on the surface are not perfectly arbitrary, but must agree with the last but one equation of the last paragraph.

Thus the values of $\delta\phi/\delta\nu$ on the whole surface are given according to equation (3).

The question whether our differential equation always admits of solution can be answered as well as for the more special equation $\Delta\phi = 0$. But that this solution has only one meaning, except as regards an additional constant, results from the following consideration: Let the functions ϕ and ϕ' both represent solutions of the problem. If we then put $\phi' - \phi = \phi_0$, then on the surface $\delta\phi_0/\delta\nu = 0$ and in the interior :—

$$\frac{\delta}{\delta x}\left[(U+V)\frac{\delta\phi_0}{\delta x}\right] + \frac{\delta}{\delta y}\left[(U+V)\frac{\delta\phi_0}{\delta y}\right] + \frac{\delta}{\delta z}\left[(U+V)\frac{\delta\phi_0}{\delta z}\right] = 0.$$

Hence by transposition of the following special integral extended over the whole solution there results :—

$$\int d\tau\,(U+V)\cdot\left[\left(\frac{\delta\phi_0}{\delta x}\right)^2+\left(\frac{\delta\phi_0}{\delta y}\right)^2+\left(\frac{\delta\phi_0}{\delta z}\right)^2\right] = -\int d\tau\,\phi_0\cdot\left\{\frac{\delta}{\delta x}\left[(U+V)\frac{\delta\phi_0}{\delta x}\right]+\frac{\delta}{\delta y}\left[(U+V)\frac{\delta\phi_0}{\delta y}\right]\cdot + \frac{\delta}{\delta z}\left[(U+V)\frac{\delta\phi_0}{\delta z}\right]\right\} - \int d\sigma\cdot\phi_0\cdot(U+V)\frac{\delta\phi_0}{\delta\nu} = 0.$$

and as U + V is essentially positive, $\phi_0 = \text{const.}$ *q.e.d.*

The potential function, ϕ, naturally determines the electric intensity of the current as well as the density of the free electricity at all points of the solution. The density of the surface charge depends also essentially on the nature of the adjacent bodies, about which we will not make any especial assumption. Hence there appears plainly the course in time of all the processes taking place in the solution. For if we have given for $t = 0$ all the osmotic partial pressures as well as the specific intensities of current for all times on the surface, we can calculate first ϕ, and then from the equations (5) and (6), the charges of the osmotic pressures occurring in the element of time, $d\,t$. Thereby ϕ is again determined for the first element of time and thus the process is further developed. By comparing the equations (5) and (6) we see readily that the influence which the fall of potential exerts on the movement of the ions is of the same order in magnitude as that resulting from the unequal distribution of osmotic pressure.

Lastly, we mention a simple but important proposition, first enunciated by Nersot, and known as the principle of superposition of the electromotive effects. Evidently all the equations which serve to determine the movement remain unaltered if we put, instead of the values $p, p' \ldots q, q' \ldots$ U, V, J_ν the n fold expressions, n signifying any given constant, positive number. Hence it follows, that multiplying by n all the concentrations and the density of the current entering from without makes no change in the potential function, the electric density and the connected values, and that the entire course of the process occurring in time appears by simply multiplying the above values by n, whilst the values of the potential function are unaffected by this change. It must be remembered that this process refers only to the main process and not also to the process of charging. It would, therefore, lose its meaning if the critical speed, c, had a decidedly smaller value.

(*To be continued.*)

ON CURRENT DISTRIBUTION IN NETWORKS OF ELECTRICAL CONDUCTORS.

By T. HERZOG and L. STARK, Buda-Pest.

THE distribution of electrical currents in any network of conductors can always be found out by employing Kirchhoff's laws, provided that the configuration of the network and the resistances of the single parts of the conduits are given. If n be the number of unknown currents, we can always set up n non-simultaneous equations and thus find out n expressions, with but one value each, for the unknown currents. The evaluation of these equations, however, requires, even in simple cases, and by aid of the determinant-calculus, much time and trouble without offering an easy overlook.

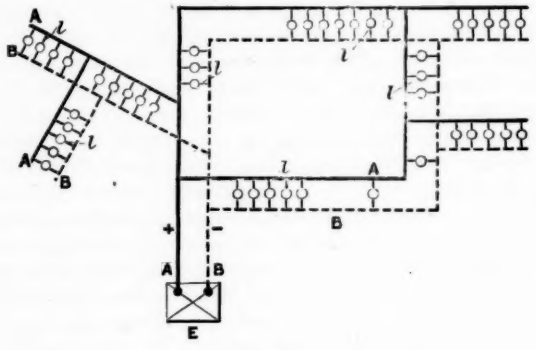


FIG. 1.

In the practice of electric illumination, nearly all networks show the same characteristic features as that represented in fig. 1. These features are :

(1) That all the current consuming devices, $l, l, \ldots$ are connected in parallel between two parallel networks, A and B, and

(2) That the mean fall of potential in the networks, A, B, amounts to only a small percentage of the useful fall of potential across the devices—that is, from the one network, A, to the other, B, through $l, l, \ldots$

In the following the principles of an approximate solution of the problems of such networks will be explained and illustrated by examples. Of these principles some have been in public use, others being used unconsciously, or half so at least, in some special cases; others still are not known yet, as far as we are aware. Undoubtedly, every practical man will welcome a summary of these principles, even if it be not systematic from the standpoint of pure science. The more will this be the case as the calculations can be made without any strain to memory or any stock of formulæ.

A relatively simple solution is obtained of the problem.

(1) To find out the distribution of current and the losses in the conductors of a network of given configuration.

(2) To observe the influence upon the total current distribution of any change of the cross-sectional area of one or some conductors, and of any variations in the currents consumed, and

(3) To calculate the sectional areas of some or all conductors—in simple cases—certain losses of potential being assumed.

The simplest case is that shown by fig. 2. A and B represent the terminals of a dynamo, or an alternate current transformer. The resistances of the devices connected between the mains as incandescent

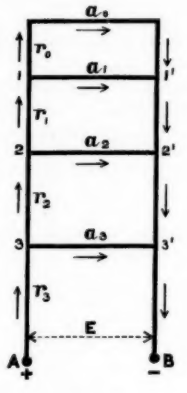


FIG. 2.

lamps, or arc lamps are denoted by $a_0, a_1, a_2, \ldots$ the resistances of the parts of the mains between the points $0\,1 + 0'\,1'$, $1\,2 + 1'\,2'$, $2\,3 + 2'\,3'$, $3\,A + 3'\,B$, being marked by r_0, r_1, r_2, r_3 respectively.

The resistance r_0 standing for the resistance of $0\,1 + 0'\,1'$
" " r_1 " " " " " $1\,2 + 1'\,2'$
" " r_2 " " " " " $2\,3 + 2'\,3'$
" " r_3 " " " " " $3\,A + 3'\,B$

The first problem is to find an expression for the total current the source A B has to supply. This source being ordinarily of nearly constant potential difference, E, between the terminals, a calculation of the total resistance of the network is sufficient, the total current intensity being then

$$T = \frac{E}{R}.$$

To find R we write successively down the resistances between the different points of derivation $11', \ldots\ldots$ A, B.

The resistance behind $11'$ is $= a_0 + r_0$. The device, a, being connected in parallel to this resistance, the resulting resistance

at $11'$ is $= \dfrac{1}{\frac{1}{a_1} + \frac{1}{a_0 + r_0}}$;

at $22'$ is $= \dfrac{1}{\frac{1}{a_2} + \dfrac{1}{r_1 + \dfrac{1}{\frac{1}{a_1} + \frac{1}{a_0 + r_0}}}}$

and so forth.

Finally, at A B, we obtain the value of

$$R = \frac{1}{\left(\frac{1}{a_3}\right) + \frac{1}{r_3} + \dfrac{1}{\left(\frac{1}{a_2}\right) + \frac{1}{r_2} + \dfrac{1}{\left(\frac{1}{a_1}\right) + \frac{1}{r_1} + \dfrac{1}{\left(\frac{1}{a_0}\right) + \frac{1}{r_0}}}}}.$$

As is well known, this expression may be independently represented as the quotient of two determinants, which would likewise have been obtained by the employment of Kirchhoff's laws. This most simple case shows distinctly how difficult and time wasting the exact determination of the total current intensity turns out. The formulæ for the currents in $a_0, a_1, a_2, \ldots r_0, r_1, r_2, \ldots$ and for the losses to the points of derivation are no less complicated, and in trying to calculate with this exact method the cross sectional areas of the mains A O and B O, under the assumption of certain losses of potential, complications not to be overlooked are met with.

In practice, of course, nobody will try to work in the above sketched manner. For practical cases an approximate method is in use which easily renders sufficiently exact results. If, in spite of this, the exact method has been touched it was merely to remind that the usual method of calculation only gives approximately correct values, a fact which is easily forgotten in the hurry of business practice.

The train of thoughts which leads to this approximate method is as follows:—The loss of potential between the points of first and last derivation may only amount to a few per cents. of the useful tension. This is the condition necessary to keep the latter nearly uniform throughout the network with a constant current supply and for admitting a slight variation only of the useful tension, with widely varying current supply. Then each device may be assumed always to take the same amount of current in inverse proportion to its internal resistance, no matter whether it be nearest to or farthest from the source and what happens with the other devices. The currents consumed by the devices may therefore be introduced from the very beginning instead of their resistances.

In the following only one of the mains shall be drawn and dealt with, the other one being congruent to it, ordinarily. Should this not be the case, the back conductor is to be dealt with in a special reckoning.

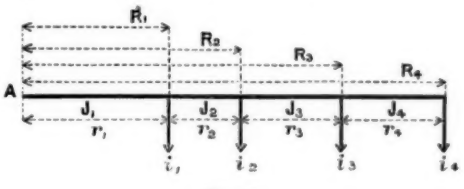


FIG. 3.

Fig. 3 may be regarded as a simplification of fig. 2. In this figure $i_1, i_2, i_3, i_4, \ldots$ denote consumed currents—$J_1, J_2, J_3, J_4, \ldots$ current sums in the respective parts of the main,—$r_1, r_2, r_3, r_4, \ldots$ the resistances of these parts,—$R_1, R_2, R_3, R_4, \ldots$ the sums of these resistances, reckoned from A.

The total loss of tension in the mains is composed of the losses in the parts of the mains; this may be written

$$V = I_1 r_1 + I_2 r_2 + I_3 r_3 + I_4 r_4 + \ldots = \Sigma (I r)$$

Substituting their values for the current sums, viz.,

$$\begin{aligned} I_1 &= i_1 + i_2 + i_3 + i_4 + \ldots \\ I_2 &= \quad i_2 + i_3 + i_4 + \ldots \\ I_3 &= \quad\quad i_3 + i_4 + \ldots \\ I_4 &= \quad\quad\quad i_4 + \ldots \\ &\ldots\ldots\ldots\ldots, \end{aligned}$$

we obtain

$$V = i_1 R_1 + i_2 R_2 + i_3 R_3 + i_4 R_4 + \ldots = \Sigma (i R);$$

thus $$\Sigma (I r) = \Sigma (i R).$$

To get the total loss of tension we have, thus, to add all the products of each device's current into the resistance between this device and the source. Calling the product of a partial current into a resistance sum the moment of the current (Hochenegg: "Ueber die Berechnung elektrischer Glühlichtleitungen," Vienna *Zeitschr. f. Elektrotechnik*, 1887), we may abridge by saying: The total loss of potential in a network, as shown in figs. 2 or 3, is equal to the sum of moments of the currents. Writing

$$V = \Sigma (I r) = \Sigma (i R) = (\Sigma i)\, \rho = I \cdot \rho,$$

we see, that the total loss of potential may also be found by multiplying the total current with an ideal resistance

$$\rho = \frac{\Sigma\,(i\,\mathrm{R})}{\Sigma\,i}$$

If the sectional area of the main be the same throughout its length, the resistances are in proportion to the lengths of the conductors. The ideal resistance, then, corresponds to an ideal distance which may be called the distance of the centre of gravity of the current-consuming devices. An explicit graphical treatment upon the calculation of conduits from this point of view may be found in the above-cited paper of Hochenegg.

The case represented in fig. 3 may be complicated by branching off second order mains which may be split up as the main in fig. 3, or further still; this enlargement of the network does not require any further explanations, each branch main being dealt with as a consuming device with regard to the main. Furthermore, each branch main is calculated like the main in fig. 2, the points, A, B, being looked at as points of derivation.

Networks of conductors, such as have been dealt with so far, may be called *open* networks. The simplest case of a *closed* network is represented by fig. 4. An

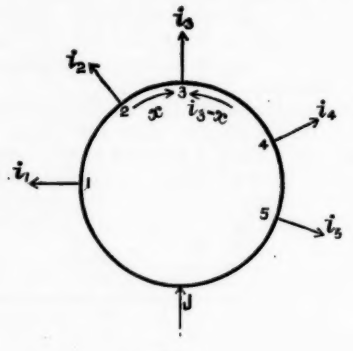


FIG. 4.

annular conductor is fed at one point, J, consumed currents being branched off at different points, 1, 2, 3. . . . At first only the total current can be found by adding the branch currents, i_1, i_2, i_3. . . . At point A the total current divides into two parts, which generally meet again at some certain point of derivation. Cutting the annular conductor at this point will exert no disturbing effect upon the current distribution. For, if this point has been determined, in some way, and found, say, at 3, current i_3 may be imagined as composed of two partial currents, the one, x, coming from the left, the other $(i_3 - x)$ from the right side. In this way, the closed ring conduit is split up into two open circuits for which the calculations can be made as above.

We now proceed to deduce a simple method to determine the point through which the cut has to be laid.

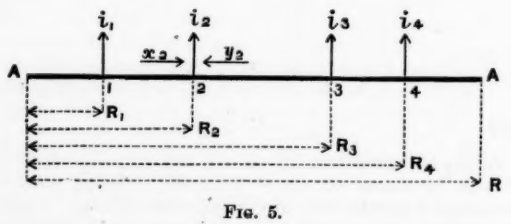


FIG. 5.

To simplify ideas, imagine the ring conduit cut at A and stretched out into a straight line as shown in fig. 5, where the denominations are analogous to those employed so far. Any branch current, then, is equal to the sum of the currents contained by the neighbouring conductor parts, *f. i.*

$$i_2 = x_2 + y_2 \qquad (1)$$

If 2 be the point where the currents from the right and left side meet, x and y have the same, say the positive, direction with regard to 2, as indicated by the arrows. If 2 be not the required point where to place the cut, one of these partial currents will arrive at this point, whilst the other will depart from it. In other words, one of them will turn out positive and the other negative in the following reckoning. Thus, the signs of these currents will prove whether the point of the cut be well chosen or not.

A determinate value of potential will exist at 2; but the loss from the left side A to 2, will be equal to that from the right side A to 2; therefore:

$$x_2\mathrm{R}_2 + i_1\mathrm{R}_1 = y_2(\mathrm{R}-\mathrm{R}_2) + i_3(\mathrm{R}-\mathrm{R}_3) + i_4(\mathrm{R}-\mathrm{R}_4) + \ldots . \qquad (2)$$

which equation will immediately be recognised as Kirchhoff's second law. From equations (1) and (2) results:

$$\begin{cases} x_2 = i_2 + i_3 + i_4 - \dfrac{i_1\mathrm{R}_1 + i_2\mathrm{R}_2 + i_3\mathrm{R}_3 + i_4\mathrm{R}_4}{\mathrm{R}} \\ y_2 = -\left(i_3 + i_4 - \dfrac{i_1\mathrm{R}_1 + i_2\mathrm{R}_2 + i_3\mathrm{R}_3 + i_4\mathrm{R}_4}{\mathrm{R}}\right) \end{cases}$$

Denoting the sum of products

$$\sum_1^4 (i_n\mathrm{R}_n) = \mathrm{M},$$

the following expressions for the currents x_n and y_n are obtained:

$$\begin{aligned}
x_1 &= i_1 + i_2 + i_3 + i_4 - \frac{\mathrm{M}}{\mathrm{R}} & y_1 &= -\left(i_2 + i_3 + i_4 - \frac{\mathrm{M}}{\mathrm{R}}\right) \\
x_2 &= \quad i_2 + i_3 + i_4 - \frac{\mathrm{M}}{\mathrm{R}} & y_2 &= -\left(\quad i_3 + i_4 - \frac{\mathrm{M}}{\mathrm{R}}\right) \\
x_3 &= \quad\quad i_3 + i_4 - \frac{\mathrm{M}}{\mathrm{R}} & y_3 &= -\left(\quad\quad i_4 - \frac{\mathrm{M}}{\mathrm{R}}\right) \\
x_4 &= \quad\quad\quad i_4 - \frac{\mathrm{M}}{\mathrm{R}} & y_4 &= -\left(\quad\quad\quad - \frac{\mathrm{M}}{\mathrm{R}}\right)
\end{aligned}$$

These equations show that

$$\begin{aligned} -y_1 &= x_2, \\ -y_2 &= x_3, \\ -y_3 &= x_4, \end{aligned}$$

which is obvious, as the currents in one and the same part of the main, reckoned for its commencement and end, can only differ by their signs. Besides, it may be noticed that every two following values of x or y differ only by the value of current, i, branched off between the respective parts of the main:

$$\begin{aligned} x_n - x_{n+1} &= i_n \\ y_n - y_{n+1} &= i_{n+1}. \end{aligned}$$

Substituting into the above given equations the numerical values of i_n, M and R, and calculating x_n and y_n, we will find two corresponding values of these currents which will both be positive. The point corresponding to these currents will show the exact place, where lay the cut. If, *f. i.* 2 be the derivation, where the division takes place, x_2 and y_2 had to be positive, or

$$i_2 + i_3 + i_4 > \frac{\mathrm{M}}{\mathrm{R}} > i_3 + i_4.$$

For all other points one of the currents would be negative. A singular case exists, if for two neighbouring points, say 2 and 3, the current in the whole distance between them become zero:

$$y_2 = x_2 = 0.$$

This shows that the part 23 could thus be omitted, and that the currents i_1, i_2 arrive from the left, and i_3, i_4 from the right side.

Now, it shall be shown that it is not necessary to calculate all the x and y to find the cutting point of a closed circuit, but that it suffices to make the calculation for any x and the corresponding y, at a point chosen *ad libitum*. The resulting values allow a conclusion upon the position of the real cutting point without any further trials, even if the first point chosen had been wrong.

The currents x and y are in intensity as well as in direction, identical with those actually flowing, and two following values of x or y only differ by the value of the current branched off between them, to which fact we referred in the discussion of the expressions for x_n and y_n already. If, therefore, for any chosen point, n, we obtain, say, a positive value of x_n and a negative value for y_n, we have to proceed in the direction of y_n to the next point of derivation, $(n + 1)$, whose current consumed, i_{n+1}, will, in general, be either greater or less than y_n. In the first case, this point will be the right point of cutting already, as from the other side another current $= + y_{n+1}$ must flow towards it which must have the same sign with regard to the point $(n + 1)$ as the current $- y_n = + x_{n+1}$. In the second case, we subtract the derived current i_{n+1} from x_{n+1}, and proceed with the still negative value of y_{n+1} till we reach the right point where to place the cut.

If $y_n = i_{n+1}$, then $y_{n+1} = 0$ and, therefore, also $x_{n+2} = 0$. This is the singular case mentioned before.

An example in numbers will serve to explain this method.

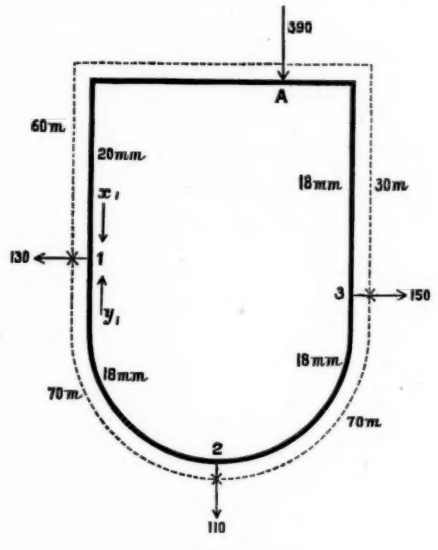


FIG. 6.

A closed main conduit is laid in the basement of a building (fig. 6) of which three conduits, 1, 2 and 3 with 130, 110 and 150 amps. respectively, lead up to the different floors. At A the current of some dynamo or transformer station enters from A to 1, a round copper bar of 20 mm. diameter is employed, the rest of the main circuit being formed of a bar, 18 mm. in diameter. The specific conductivity of copper is taken as 60.

If we imagine the cut at any point, *f. i.* at 1, we obtain the following equations for this point:

$$x_1 + y_1 = 130 \qquad (1a)$$

$$x_1 \frac{60_m}{60 \frac{20^2\pi}{4}} = y_1 \frac{70_m + 70_m + 30_m}{60 \cdot \frac{18^2\pi}{4}} + 110_A \frac{70_m + 30_m}{60 \cdot \frac{18^2\pi}{4}} + 150_A \frac{30}{60 \frac{18^2\pi}{4}} \qquad (2a)$$

whence $\begin{cases} x_1 = 172 \text{ amps.} \\ y_1 = -42 \text{ ,,} \end{cases}$

Hereby we have also received the right values of the currents together with their direction. The part A—1 thus contains a current of 172 amps., the derivation at 1 taking 130 amp.s; in the part 1—2 a current of 42 amps. continues to flow in the direction towards 2, where 110 amps. are consumed by addition of 68 amps. from 1. Between 2 and 3 a current of 68 amps. must, therefore, be flowing towards 2, whilst the distance A—3 is passed by a current of 68 + 150 = 218 amps. in the direction towards 3.

We see that 2 is the point where to open the closed conduit by attributing 42 amps. to the left side and 68 amps. to the right side conduit. The tension loss to this point in the main conduit amounts to 0·74 volts, as calculation shows, and if the return conduit is congruent to it, the loss in both is equal to 1·48 volts.

In order to show that the same result had been obtained by choosing any other point of derivation, the equations (1) and (2) shall be set up for the point 3, also. Here

$$x_3 + y_3 = 150 \qquad (1b)$$

$$y_3 \cdot \frac{30}{60 \cdot \frac{18^2\pi}{4}} = x_3 \left(\frac{70 + 70}{60 \cdot \frac{18^2\pi}{4}} + \frac{60}{60 \cdot \frac{20^2\pi}{4}} \right) + 110 \left(\frac{70}{60 \cdot \frac{18^2\pi}{4}} + \frac{60}{60 \cdot \frac{20^2\pi}{4}} \right) + 130 \frac{60}{60 \cdot \frac{20^2\pi}{4}} \qquad (2b)$$

whence $\begin{cases} x_3 = -68 \text{ amps.} \\ y_3 = 218 \text{ ,,} \end{cases}$

in exact conformity with the former values. Proceeding with 68 amps. from 3 towards 2, we notice that 42 amps. must arrive at 2 from the other side, 2 being the right point of cutting, as was also found with x_1 and y_n.

Besides it may be mentioned that by employing a copper bar of 18·6 mm. diam. throughout, the same loss of potential had been attained with less expense of copper.

Many networks of town lead to the case just dealt with. If, in fig. 7, O is the central station, and I

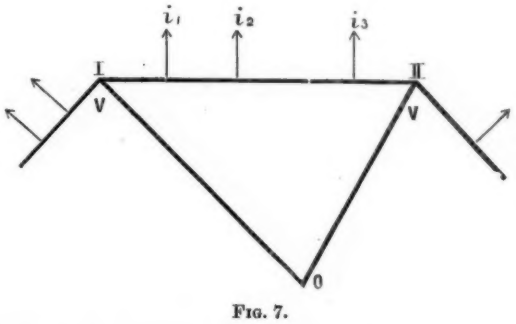


FIG. 7.

and II are the points where the points O I and O II join and if, besides, the tension at the points I and II is kept upon the constant value, V, independent from the current consumed, the reckoning with regard to the distributing main I II leads to the above treated solution.

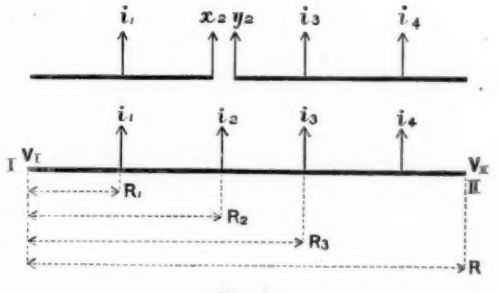


FIG. 8.

If, however, the tension V_I at I differs from that V_{II} at point II (fig. 8), the reckoning is altered somewhat. If, namely, the tension at 2, reckoned from I

shall be equal to that reckoned from II, the loss v_1 from I to 2 may not be equal to the loss v_{II} from II to 2, but:

$$V_I - v_I = V_{II} - v_{II}$$

or

$$V_I - 2(x_2 R_2 + i_1 R_1) = V_2 - 2[y(R_1 - R_2) + i_3(R - R_3) + i_4(R - R_4)]$$

furthermore $x_2 + y_2 = i_2$, as before, whence

$$\begin{cases} x_2 = \dfrac{V_1 - V_2}{2R} + i_2 + i_3 + i_4 - \dfrac{M}{R}, \\ y_2 = i_2 - x_2. \end{cases}$$

Thus the contemplation made for the simple ring conduit is valid here also and the method is essentially the same as before; at any point of derivation we imagine the departing current, i, subdivided, write down the two equations for tension and current, and calculate the current distribution for the chosen point of cutting which will be identical with the actual distribution and will at once lead to the true point where to place the cut for reckoning the total loss of tension.

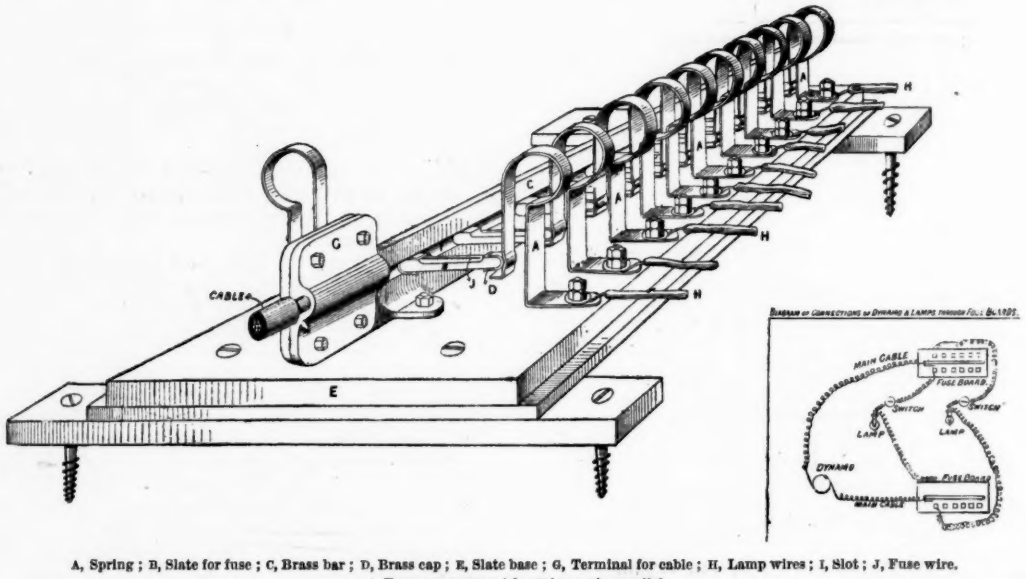
If other current consumers are branched off to the left of I or to the right of II, it may happen with larger differences between V_I and V_{II} that the true point of cutting does not lie upon the distance I II, but falls either upon the points I or II, or—if more feeders than A I and A II should exist—lies somewhere between the points of junction of these feeders.

(To be continued.)

WALTON'S FUSIBLE CUT-OUTS FOR ELECTRICAL CIRCUITS.

THE object of the inventor of these cut-outs was to obtain a reliable method for making safe contacts for fuse wires. In the ordinary direct supply of electricity from central stations, mains of large sectional area have to be employed from the point of supply, to which mains the lamp wires are jointed as required. It is suggested that considerable economy would result from bringing all lamp wires which, preferably, supply only one lamp each in a house or building to one central point (this point can be maintained at a constant difference of potentials by any of the usual methods), thus forming a sub-station or distributing centre. Then as each lamp wire is independent of all variation of load, that is to say, the one lamp is either on or off, the volts lost in any one pair of lamp wires (positive and negative) do not vary; thus the size or area of the lamp wires is governed solely by the heating limit, and for long distances lamps of lower electromotive force may be used.

A large number of wires, however, all coming to one central point require some form of connection which ensures safe contact and easy distinction or separation of any one wire. This system provides such a connection, with the further safeguard and economy of including with it a separate fuse to each lamp in both positive and negative wires, thus saving the expense and risk of the usual small separate fuse-boards or plugs, and also the insulated soldered joints to mains. The usual form of fuse attachment to plugs or boards necessitates more or less expensive fittings, and, further, it is impossible to secure constant perfect contact by squeezing soft metal, such as tin or other fuse wire, under screws or bolts, as the metal having little or no elasticity, simply yields to the pressure of the screw, and soon works sufficiently loose at the point of contact to become so hot as to cause the fuse to melt.



A, Spring; B, Slate for fuse; C, Brass bar; D, Brass cap; E, Slate base; G, Terminal for cable; H, Lamp wires; I, Slot; J, Fuse wire.
+ Fuse arrangement for 20 lamps in parallel.

It will be seen from the accompanying illustrations of Mr. Walton's method that the fuse wire contact is not dependent on any screw which can flatten the wire without following up the loss of pressure, but a special form of spring, A, is employed which provides a constant pressure on the fuse wire. The fuse wire is easily placed in position without the use of any tools, a strip or bar of insulating material, B, carrying the fuse, J, being held in compression by the spring, A, against a central brass bar, C, and by means of brass caps, D, fitted on each end of the insulating strip, B, the fuse wire is thus protected from abrasion and permanent good contact is ensured. The spring, A, and central bar, C, are fixed on a slate or other insulating slab, E, by bolts, the end of the bar, C, being provided with a loose socket or terminal, G, to which the feeding main can be brazed or soldered and then mechanically bolted to the bar, C, thus providing a certain and permanent contact. The lamp wires, H, are secured by the nuts on the bolts to the spring, A, a slot or groove, I, is cut longitudinally on each or both sides of the central bar, C, to receive the capped end of the insulating bar, B. The figures show fuse arrangements for twenty lamps, two such boards being required (one for positive circuit and one for negative circuit) for one house and fitted with the requisite number of springs.

CARDEW EARTHING DEVICE.

MESSRS. DRAKE AND GORHAM have considerably modified and improved the Cardew automatic earthing device, and we give herewith an illustration of the latest perfected pattern which has been finally adopted by the London Electric Supply Corporation after an exhaustive series of tests, and will shortly be in use over all their London circuits. The necessity for apparatus of this class was foreseen by Major Cardew some time back, and his patents, which are held by Messrs. Drake and Gorham, cover devices which depend for their action on static attraction or made on the Geissler tube or similar principles.

The static arrangements have been found to give the best results, and have been adopted in the standard instrument as being less liable to derangement.

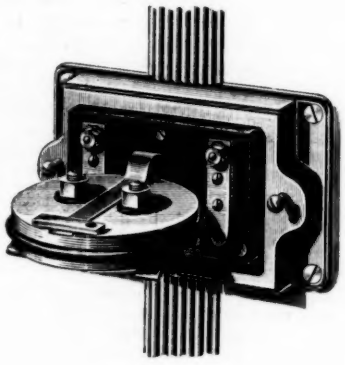


FIG. 1.

The action of the device is to connect the secondary circuit to earth automatically whenever a dangerous difference of potential is established between the lamp circuit and earth. This result is obtained by interposing some medium which will be of infinite resistance until a high voltage exists, when a free passage for the current is provided.

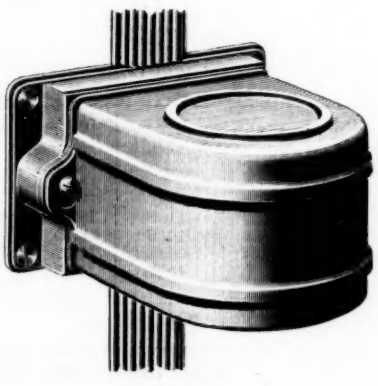


FIG. 2.

The static device illustrated consists of two brass plates placed near, but insulated from each other. Between these lies a thin foil of aluminium which is retained in position by ebonite pegs, one plate being connected to earth and the other to the secondary circuit.

A flat projection is formed on the upper plate over one end of the foil, so that as soon as a difference of 400 volts is established, one end of the foil lifts by static attraction, and a metallic contact is made between the two plates. The main primary fuses are immediately severed by the increase of current, and the supply is cut off.

The two plates are insulated by ebonite rings, and are securely bolted together, so that after being tested at the central station, no skilled labour is required to fix them. It has been shown that the plates can be shaken or rolled about without affecting the voltage at which the foil will lift.

The plates are carried by brass springs to which the connections are permanently made at the back of a solid block of ebonite, so that the act of sliding in the plates makes the connections, and a slot on one side renders it impossible to put them in with the wrong side uppermost.

The plates are all made interchangeable, so that when the foil has acted it is merely necessary to slide in some fresh plates.

It has been suggested that the connecting of the secondary circuit permanently to earth will remove the necessity for this device; but there is no comparison, from a fire risk point of view, for a strain is permanently put on the insulation of the conductors, and a slight leak, which with the automatic device would remain harmless for years, is liable to be developed at any time into a state of danger. This is especially the case in damp situations where the size of the conductor may be reduced by corrosion.

It is evident that the apparatus can be modified to act as a relay and cut off both poles of the circuit, or to ring a bell and drop a danger disc, as has been arranged for the Chelsea Electric Supply Company, where continuous currents are used.

In addition to the Deptford Company, the instruments have been supplied to the Newcastle Electric Supply Company, the Central Station at Lynmouth, Devon, the Shanghai Electric Company, &c.

SOME TESTS ON THE EFFICIENCY OF ALTERNATING CURRENT APPARATUS.*

By Dr. LOUIS DUNCAN and Mr. W. F. C. HASSON.

SEVERAL papers have appeared lately on the efficiency of alternating current transformers, some of which have been of a more or less theoretical nature, while others have given the results of actual tests. I have, never, however, seen any tests on alternating current dynamos, excepting the experiments made by Dr. Hopkinson and Prof. Adams on a de Meritens machine used for lighthouse work. Even the converter tests have given such varying results that one can hardly be certain as to the real efficiency.

The introduction of the alternating system has been so rapid and is so rapidly increasing that people are apparently well enough pleased with the results not to bother about the smaller question of the reasons for them. But whatever the results may be it is of value to know just where the losses in any system may come in, so that we may seek how to avoid them; if we are succeeding, it may enable us to increase the profits—if we are losing, it may help us to avoid further loss.

The apparatus, the measurement of which is the main subject of this paper, consisted of a Westinghouse 750-light No. 1 dynamo, with a No. 2 exciter and an outfit of 40-light converters. This apparatus had been presented by the Westinghouse Electric Company to the John Hopkins University, and was tested a couple of months ago. The workmanship of the machines is excellent.

The plant consisted of a 75 H.P. Armington and Sims engine driving the dynamo and exciter through a Tatham transmission dynamometer. Engine, dynamometer and dynamos were firmly secured to heavy parallel timbers which served as a foundation. The converters were banked on a wooden framework at a distance of some 30 yards from the dynamo, and their primaries were permanently secured to the dynamo circuit, a switch in the latter serving to cut them off

* A paper read before the American Institute of Electrical Engineers, March 18th, 1890.

when desired. The ammeter belonging to the plant was put in this circuit and was read when efficiency measurements were being taken. The secondaries of the converters were taken to a switchboard and then to incandescent lamps mounted on racks.

Power measurements.—The Armington and Sims engine supplying the power worked regularly and satisfactorily and the governor could be adjusted to give the speed required at the dynamo. The Tatham dynamometer was the one used for power measurements at the International Electrical Exhibition, held in Philadelphia, in 1884, where its accuracy was checked by making with it a determination of the mechanical equivalent of heat. The result obtained in the latter measurement was 772·8 foot-pounds per degree Fahr., and shows that the dynamometer is practically accurate. A description of the experiments and of the instrument may be found in the report of the test made to the Franklin Institute, but it will not be out of place to briefly describe the apparatus here.

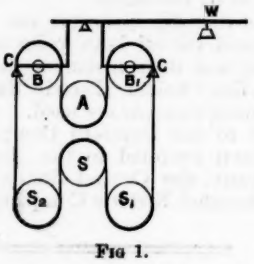


FIG 1.

An endless belt, as shown in fig. 1, passes over the driven pulley, S, to the shaft of which the engine is belted, round the pulleys, S_2 and B, to the driving pulley, A, and back over B_1 and S_1 to S, again. The bearings of the pulleys, B and B_1, are in cradles pivoted on knife edges, C, at their outer ends, and at the inner ends are connected by links at equal distances on the two side of a knife edge which supports the scale beam, W. The outer side of the belt passes through the line of the knife edges, C, and therefore has no effect on the scale beam, but the tensions of the inner parts of the belt act directly on the scale beam, and as they are on opposite sides of the fulcrum they act against one another. The beam is so graduated that this difference of tension is read off directly in pounds, and this quantity—the difference of tension of the belt on the two sides of A—multiplied by its circumference and speed, gives the horse-power delivered. A weight travels on the beam, W, and readings can be taken with great accuracy.

Electrical measurements.—The energy in the secondary circuit was measured by means of a Cardew voltmeter and a Thomson ampère balance. As it is not the custom to put a number of secondaries in parallel, each converter had its separate lamp circuit.

Before making an efficiency test, the potential difference in the primary was regulated—there being a Cardew voltmeter in that circuit—and a separate measurement of the potential difference and current in each secondary circuit was made. When the test was actually in progress the voltmeter and ampère balance were used in one of the circuits and the currents and P.Ds. in the others were calculated from the readings in this circuit together with the previous measurements. Both the voltmeter and ampère balance were accurately calibrated, the former being checked after each test, while the latter had its constant determined with both continuous and alternating currents. The P.D. at the terminals of a non-inductive German-silver resistance in circuit with the balance was observed, when a continuous current was flowing, and also with an alternating current of the same period as that employed in the test. The current in each case was calculated from the resistance and P.D., and the results gave no appreciable difference in the constant for continuous and alternating currents.

The following tables show at once the order in which the tests were carried out and the results :—

HORSE-POWER ABSORBED AT VARYING E.M.Fs.

	E.M.F.		H.P.
	Dynamo.	Exciter.	
H.P. for exciter, field not made ...	0	0	·34
" " field made	0	110	·75
" " dynamo alone	0	0	2·73
" " dynamo and exciter	0	0	3·04
" " " " "	0	107	3·51
" " " " "	1376	124	12·5
" " " " "	1168	104	10·1
" " " " "	1099	105	9·60
" " " " "	1040	105	9·0
" " primaries of converters on ...	1216	105	12·0
" " " " " ...	1171	104	11·8
" " " " " ...	1107	104	11·12
" " " " " ...	1048	104	10 64

TABLE OF EFFICIENCY AT VARYING LOADS.

Approximate load.	Exciter.		Dynamo primary.		Converters.		Horse-power in lamp circuit.	Mechanical horse-power.	Loss in horse-power.	Efficiency.
	E.M.F.	Current.	E.M.F.	Current.	E.M.F.	Current.				
										Pr. cent.
¼	105	9·4	1107	10·	49·5	153·9	10·21	21·83	11·62	46·8
½	104	10·5	1107	18·9	49·6	338·4	22·50	34·4	11·90	65·4
¾	101	11·	1113	28 6	50·0	520·7	34·9	48·0	13·1	72·7
Full	112	11·5	1123	38·1	50·9	739·8	50·48	64·44	13·96	78·3

EFFICIENCY OF CONVERTERS.

No. 8. 40-light Converter.

No. of lamps.	Volts.	Watts in secondary.	Loss in watts.	Loss in iron.	Efficiency.
40	50·0	2,001	109	...	94·8
0	50·9	0	84	84	...

No. 4. 20-light Converter.

No. of lamps.	Volts.	Watts in secondary.	Loss in watts in secondary.	Loss in iron, watts.	Efficiency.
20	48·8	952	106·	95·2	90·0 per cent.
15	52·2	817	114·8	108·9	87·6 "
10	50·3	506	101·7	99·2	83·3 "
5	51·44	264	109·4	108·7	70·7 "
0	52·3	0	110·5	110·5	0· "

The efficiency of the converters was measured by placing them in a metal calorimeter, between the double walls of which water was allowed to flow. The temperatures of exit and entrance were observed, as well as the weight of water which passed through ; at the same time the current and P.D. in the secondary circuit of the converter were measured. A separate observation gave the radiation, which was of course allowed for, although it was made as small as possible. A number of converters were experimented on but I give but two of them ; a 40-lighter, such as was used in the tests, and a 20-light converter which was very carefully tested by two of my students, Messrs. Bliss and McKeen. In the latter case the observations were made at slightly different P.Ds, and the results show that the loss in the iron varies as we would expect it to vary, that is, very nearly as the square of the voltage. The variation will not be exact, as the losses due to the reversal of magnetism do not vary quite as fast as the square of the induction.

I would like here to call attention to the fact that in an excellent paper read before this institute, Professor Ryan, of Cornell, found that the losses in the iron of a 10-light converter decreased greatly as the load increased. This was accounted for by the fact that there was a jar (evidenced by the singing of the converter) at the higher loads, due to the attractions of the secondary and primary coils. While it is true that the losses in the cores of very small converters are not exactly constant, yet they are nearly so, and a large part of the decrease found by Prof. Ryan is due to the voltage being greater at the low than at the high loads.

Looking now at the figures given in the tables we are struck by two things; the very large amount of power absorbed in the core of the armature, and the very small loss in the converters on open circuit. The dynamo losses due to reversals of magnetism and eddy currents, at the E.M.F. used in the test are no less than 6 H.P., while the energy due to reversal of magnetism and eddy currents in the 16 converters is only 1·6 H.P. Another rather striking thing is the almost constant ratio of primary and secondary currents over a considerable range. The maximum efficiency is about 78 per cent. It would seem that the losses could be divided into a constant part, and one varying with the current, but this is not true with the older style and smaller converters of the Westinghouse company.

Suppose we have a plant such as is described above, and use it for commercial lighting. Taking data from one of the local companies employed in supplying incandescent lights on this system we have, for two 2,500 light dynamos, the following outfit of converters :—

Size of converters.	Capacity.	Number in use.	Total lamps.
No. 1	5 16-C.P. lamps	44	220
No. 2	10 „ „	61	610
No. 4	20 „ „	43	860
No. 6	30 „ „	49	1,470
No. 8	40 „ „	64	2,560
	Total lamp capacity.....		5,720
	Number of lamps supplied.....		4,557

I understand that the converters being added are of the larger sizes.

The efficiency of the 30-light converters does not differ greatly from that of the 40-lighters. The accompanying fig. 2 is a load diagram of this plant, selected from a number of diagrams as giving a fair average curve. If we have our dynamo working to its full capacity then from the above data we would have a converter capacity of 23 40-light converters.

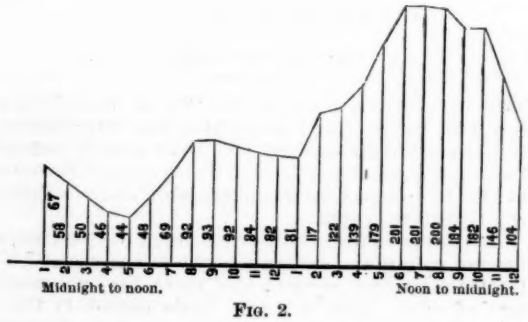


FIG. 2.

If, as in our test plant, these converters are 40-lighters, or 30-lighters—for the efficiency of these two sizes is about the same—we would have a mean loss in our plant of, say, 10 H.P. in our dynamos ($9{\cdot}6 + C^2 R$), and in the converters about 3 H.P. ($2{\cdot}3 + C^2 R$); or all together about 13 H.P. From the above table we will have 750 lamps supplied, and taking the data from the load curve the average load would be in the neighbourhood of 1,300. This corresponds to about 20 H.P., and the efficiency of the plant for 24 hours would be $\frac{20}{33} = 61$ per cent., minus the percentage of loss on the lines. This, in a properly installed system, should not average 2 per cent., so that the final efficiency would be 59 per cent.

A continuous current dynamo supplying the same outfit of lamps, with a maximum loss in the mains of, say, 15 per cent., would have a greater average efficiency. But I wish to point out that the maximum efficiency of the two plants would be about the same, so that they would require the same capacity of station outfit, boilers, engines, dynamos, &c. When more than one dynamo is provided the efficiency is increased by using only one of them during the times of minimum supply, and always working as far as possible only a little below the maximum capacity of the machines.

Let us consider these results in view of the present condition of incandescent light distribution in the United States. I take it that what may be called domestic electric lighting is largely a matter of the future—it is certainly not a matter of the present. The majority—the great majority—of the lights in use are in shops, saloons, theatres, offices, &c. Most of the lights wired are in use at one time or another during the 24 hours, and the proportion of energy supplied to the total capacity of the lamps connected is much greater than it would be in the case of house lighting, where, on the average, only a small fraction of the possible lamp hours are actually in use. Under these circumstances the scheme of alternate current distribution is very different from what it will be when the attempt is made to supply an entire city with light, as they are attempting to supply London at the present time.

If the object of the lighting company is to supply the demand that exists at present, then a system employing a number of small converters is preferable. Such a system is flexible and can be installed with a minimum expense for the more or less scattered demand which is presented in even the most closely settled town. I take it that this is the great difference between the alternating and direct systems as at present installed in this country. The former skims over an extended district, taking advantage of its great flexibility to absorb any business which can be got; while the latter settles itself in a densely built centre, installs a larger plant than is primarily demanded, and works up a business within the limits of economical distribution. Therefore, it is hardly right to compare the present systems of direct and alternating supply; as the latter has not been reduced to a point where entire districts are to be supplied.

To show the disadvantage of the present system for domestic supply, suppose we have an ordinary house such as one of us would live in; it would be necessary to have a converter of at least 20-light capacity. The constant loss is, say, 100 watts; so, leaving out the $C^2 R$ loss, we would have a total loss in 24 hours, of $\frac{2400}{100}$, or about 3 H.P. hours, corresponding to, say, 45 lamp hours. Taking my own experience the actual number of lamp hours used is about 30 lamp hours during 24 hours, so the efficiency of the converter would be something like $\frac{30}{75} = 40$ per cent. It is evident that unless the losses in converters can be greatly decreased, a house-to-house distribution with a converter in each house would hardly pay.

It would seem, then, that if gas is to be really displaced and serious competition with it is to be attempted, a different system of distribution must be worked out. We must replace the numerous small converters with one large converter supplying a comparatively extended district, thus decreasing the converter capacity, since the law of average can be taken advantage of, and greatly increasing the efficiency. If an extended secondary network is employed, some of the converters may be disconnected from the mains at the turn of minimum demand.

(To be concluded.)

ELECTRIC LIGHTING OF CHELMSFORD.

ON Monday last there was formally inaugurated the public lighting of Chelmsford, for although the town has been lighted by electricity for some weeks past, it was only on that day that the Corporation dated the commencement of their contract with Messrs. Crompton and Company, Limited, and officially recognised the improvement brought about in their streets by the substitution of electric in the place of the old gas light.

Chelmsford, quiet and unobtrusive country town as it is, has set an example which might be, with advantage, followed in other places, and it can boast, certainly with some justification, of being the only one in this country where throughout its whole area gas has been superseded by its more modern rival. In inception, in maturing, and in its successful accomplishment, the scheme for this installation has been the work of its own inhabitants and manufacturers, who have carried out the matter with the minimum of assistance from extraneous sources. But the electric light is there; how marked a contrast to the fate of schemes for the proposed lighting of several other cities we might mention, where the sole result apparently reached has been the complete waste of time, energy and money on the part of the unfortunate electrical engineers, who foolishly were induced to submit their tenders. Improvement had to recede in presence of the vested or gas interest. Even at Chelmsford this latter power had to be overcome, not without a hard fight, while the rancour thereby engendered has scarcely yet passed away. The opposition might not have been so readily subdued had not Messrs. Crompton & Co., who have extensive works in the town, met the municipal authorities on almost all points, and entered into a contract with them for the supply of public lighting for five years, at a price which alone can hardly be remunerative. A clause in the contract enables Messrs. Crompton & Co. to provide private lighting for such persons as may require it, and it is to be hoped that the charge per unit may be fixed at a sum sufficient to produce a profit, provided that the townspeople do not prove niggardly in their consumption of the electric current. At the end of five years, if the Corporation do not renew the contract for public lighting, the contractors still have the right to supply private wants for another five years. Their contract was accepted by the Town Council on March 27th last year, the work was immediately put in hand, and the lighting was to have commenced on September 8th. Through a difficulty in getting the materials, however, and the numerous alterations in the original scheme insisted upon by the Board of Trade inspector, great delays occurred, and the work was not finished till about a month ago. The three main streets of the town are lighted by means of 18 arc lamps, for each of which the Town Council is to pay £22 10s. per annum, and the other streets by 210 incandescent lamps, for each of which the charge will be £2 6s. 10d., the total annual cost thus being £873 6s. 8d. This is against £768 formerly paid to the gas company for only 188 lamps. The contract is for five years. There is to be a fine of 4d. per hour for every arc lamp which goes out and ½d. an hour for every incandescent lamp. A breakdown is guarded against by reserve machinery, but if the light should fail Messrs. Crompton will be liable to a fine of £500. A Board of Trade license has been applied for by the firm.

The steam engines and dynamos forming the generating plant are located at Messrs. Crompton & Co.'s works, a portion of which premises has been set apart for public lighting purposes. The distributing mains, mostly carried overhead, are of Silvertown manufacture, and these cables are suspended from steel wire stretchers from pole to pole. The distance between each pole never being more than 80 yards—the normal interval selected here for placing arc lamps—while the exigencies of construction and the difficulty of spacing the poles to meet the views of the Board of Trade, having rendered it compulsory for the contractors to use a greater number of poles than would ordinarily be required, conduce to produce a rigid and horizontal appearance in the wires not without attendant advantages in other respects.

Strenuous opposition was offered to the overhead system, its lesser cost for erection and maintenance in a somewhat straggling area like Chelmsford, however, gained the day over the advocates for underground distribution. To comply with the Board of Trade rules that no main wires shall be placed at a less distance than 6 feet from any building, the mains, owing to the narrowness of the side walks, had to be erected on suitable wrought iron brackets attached to the poles extending over the roadway away from the houses. The arc lamps lighting the most important streets are worked from a continuous current machine. The remainder of the streets are lighted by incandescent lamps, the distribution of the electrical energy being, by alternating currents of high potential, converted by transformers into currents of low tension; the transformers are placed on the poles carrying the overhead wires. The transformer system is also to be used for the private supply. The 210 incandescent lamps scattered along the less important parts of the town are of 32 candle-power, and although incandescent lamps are not considered the best means for lighting streets, they seem in this case to give general satisfaction, the consensus of opinion being that they produce a better effect than the displaced gas lamps. All the glow lamps are worked at a transformed pressure of 100 volts.

The practical success of the installation has been achieved through the untiring zeal of Messrs. Crompton & Co.'s, engineers, more particularly, perhaps, Mr. A. J. Pott, who has made it his special study, and whose duties during the course of operations cannot have been a mere sinecure, when one considers the numerous difficulties connected with electrical engineering sure to arise, and putting on one side the manifold troubles in regard to way-leaves and disputes with the Board of Trade.

The inauguration of the town lighting took place just before seven o'clock, in the presence of the Mayor and a large concourse of people, when the lights were switched on by the Mayoress (Miss Brown) and the ex-Mayoress (Mrs. Chancellor). To celebrate the event a public dinner was afterwards held at the Saracen's Head Hotel, the Mayor (Alderman J. S. Brown), Chairman of the Electric Lighting Committee, presiding; and among the guests present were several members of the Corporations of Chelmsford and other towns, Mr. R. E. Crompton, Mr. Spagnoletti, and other distinguished electrical engineers. In the course of the after-dinner speeches, the town was congratulated upon being the first in the country lighted throughout by electricity.

THE INTRODUCTION OF ELECTRIC LIGHTING IN BUDA-PEST.

[FROM A CORRESPONDENT.]

THE negotiations between the City of Buda-Pest and the local gas company concerning the introduction of the electric light—which you have already noticed—have now entered upon a stage which appears favourable to the long-hoped-for installation of electric light in the Hungarian capital.

According to the existing agreement the gas company has not merely the exclusive right to the use of public localities, streets, squares and lanes, for light conductors of every kind (electric leads included) for the term of the agreement, but for ten years after the expiry of the same, in case of the grant of concessions for the use of lighting arrangements of any kind, it enjoys the priority as against all rival applicants. By these privileges the free development of the electric light in Buda-Pest has been essentially hindered. Hence the capital of Hungary has, in this important matter, been outstripped, not merely by other European capitals, but

by unimportant provincial towns, both at home and abroad.

This very unsatisfactory condition of the Hungarian metropolis will now speedily cease—if the recent proposals of the gas company are accepted—and the city will obtain the right of granting, at its option, concessions for erecting electric works in Buda-Pest. The gas company is desirous of obtaining the prolongation of its agreement for a further term of ten years, and has declared itself satisfied with the modifications already mentioned in your paper, and also to include electric lighting in the scope of its activity. The committee appointed for the negotiations has demanded, in return for the prolongation :—

a. That the price of gas per cubic metre shall be reduced to 10 kreutzer ;

b. That the gas required for public lighting shall be supplied gratis for all the lamps, and without including the cost of maintenance ;

c. As regards electric lighting the company shall claim neither the exclusive right nor the priority, and the cost of the electric light must not exceed the present price of gas.

In the reply to the gas company these proposals are discussed separately and jointly with regard to their practical signification, and it is shown that the acceptance of the demands raised would involve a sacrifice of 3½ million florins—a sum so exorbitant as to be out of the question if the agreement is prolonged with all its conditions, including the monopolistic exclusion of all other sources of light. In order under such circumstances not to interrupt the progress of the negotiations it is attempted, in accordance with the wish of the President of the Committee, to find a solution of the question as regards gas light alone, separately from the question of electric lighting. To this end the following proposals were made :—

"On condition that the agreement between the capital and ourselves for the exclusive right to supply gas light is prolonged for 15 years we are prepared to renounce our right to the introduction of the electric light or any other means of illumination, and to leave the municipality in perfect freedom. We merely stipulate that the competition must remain free, that no one receives a privilege, a favour, an exception, or an advantage as compared with other competitors, so that every one, including our company, may compete on an equal footing, and submit proposals. By this conditional renunciation the capital is enabled at once to enter into negotiations for electric lighting, to invite competition, and to select the most advantageous proposal. The prolongation of the gas agreement will not interfere with all this in the least."

The gas company is still prepared, immediately on the acceptance of the prolonged agreement, to reduce the price of gas for private consumers successively down to a minimum of 10½ kreutzer per cubic metre, and for public lighting to furnish gratis, after the expiry of the present agreement, the gas required in the proportion of the effective consumption of 1888.

As regards these proposals, the Committee declares that the offer of the gas company is an effective, valuable concession. The capital can now proceed freely with or without the gas company, as may be found advantageous, with the installation of the electric light. At the same time, there is the prospect of reducing to a minimum the cost of public lighting, and of greatly reducing the price to private consumers. Generally, the offer of the company may be accepted as a basis for detailed negotiations.

The Committee will probably formulate certain wishes going beyond the proposals of the gas company, *i.e.*, that the price of gas to private consumers should be at once reduced to 10 kreutzer (about 2d.) per cubic metre. But it can scarcely be doubted that an agreement will be soon reached as regards the critical points.

According to the calculations of the chief municipal accountant, the concessions made by the gas company in their last proposal represent a fixed amount of 1½ million florins, and a yearly performance of 243,000 florins, to which must be added the company's renunciation of its prior claim as regards the introduction of other means of lighting. These are the compensations which the gas company is prepared to make to the city for the prolongation of its gas agreement for 15 additional years.

The report of the sub-committee charged with the conduct of the negotiations concludes with the following two proposals :—

1. The gas company shall be required to constitute their works at Buda Pest as an independent undertaking.

2. After the acceptance of the agreement with the gas company the sub-committee shall determine the conditions, on the basis of which a public competition for the introduction of the electric light in Buda Pest shall be invited.

NOTES.

Church Lighting at Bournemouth.—At the Easter Vestry at St. Michael's, Bournemouth, Mr. Pearce called attention to the subject of the electric light, and submitted an estimate which had been given him of the probable cost of lighting St. Michael's Church. It appeared that the cost of fitting would, in the first instance, amount to about £200, and that the cost of the light thereafter would probably be less than gas, as used at present ; but as gas would also be required in connection with the system of warming, it was considered that all that could be done for the present was for the churchwardens to keep the matter "in view."

The Electric Light in Belgium.—The Société L'Electrique of Brussels, which works the Julien system of accumulators, has just made an important installation of the electric light in the palace of the Comte de Flandre at Brussels. The lighting includes at present three arc lamps in the State court yard and 900 incandescent lamps, divided as follows : 178 in the library, the dining hall, the billiard room, and the prince's private apartments ; 574 in the reception saloons, 27 in the guests' chambers, 28 in the children's apartments, and 93 in various other rooms. The primitive installation of the motor power, placed in the cellars, included in the first place a four horse-power motor for charging a battery of Julien accumulators for serving the private apartments only. This has been increased by the addition of a 20 horse-power motor for charging a battery of 36 accumulators. These are charged every eight days, according to need. This plant, which is entirely supplied by accumulators, allows of the light being had at any hour without setting the engines to work. The success, it is said, has been so great that the Comte de Flandre is now preparing for the installation of the light in all the offices of the palace, stables, kitchens, servants' bedrooms, &c., which will raise the total installation to 1,500 lamps.

Theatre Lighting.—The Chicago office of the Thomson-Houston Electric Company has installed a novel arrangement for securing an abundance of soft light in Jacob's North Side Opera House, with perfect ventilation. The device is, in form, similar to a large parasol, 18 feet in diameter, the perforations in the cover permitting the escape of the vitiated atmosphere. The rod and handle are formed to permit the use of gas jets if necessary, while from the tip of each rib incandescent bulbs hang to form a perfect and powerful circle of light. Another feature is the use of incandescent bulbs, arranged in a wire net, to indicate the name of the company playing.

Bromley Lighting.—The Bromley Local Board has appointed a committee to report upon the question of lighting the town by electricity.

Electric Lighting Charges at Eastbourne.—At the monthly meeting of the Eastbourne Town Council on Monday, a letter was reported to have been received from the Board of Trade, in reference to the proposed charges of the electric lighting company, stating that the charges should be eightpence instead of tenpence per unit. Alderman Boulton, who spoke on behalf of the electric light company, said that if the Board of Trade fixed the rate at 8d. per unit the Corporation could not be supplied at that rate. Alderman Wallis observed that it seemed strange that the Board of Trade should have so advised in reference to a provisional order. In his opinion it was the business of the Corporation to say how much they felt justified in paying for lighting the parades for the good of the town. Alderman Boulton explained that it would be impossible for the company to work at a profit if they charged less than tenpence. Other speakers, however, professed to see no reason why the advice of the Board of Trade should not be acted upon, or why Eastbourne should pay more than other towns for the electric light. Eventually a resolution to the effect that the Corporation saw no reason why the Board of Trade fixture of 8d. per unit should not be accepted, was carried by a majority, Alderman Wallis protesting that it meant death to the electric light in the town. It was stated by Alderman Boulton that the electric lighting company would go on as before without any provisional order from the Board of Trade.

The Electric Light in China.—The electric lighting of Canton has made further progress, the dynamos and engines built in San Francisco having arrived. There has been some fear lest the spirit of conservatism, which is so essentially a characteristic of the Chinese, should lead them to take violent measures against the innovation. With the view to prevent any action of the kind, the viceroy, Li-Hung-Chang, has issued a proclamation forbidding any interference with the new light, which, although unforeseen by Confucius, the viceroy goes on to say, will prove a means of averting, in a great measure, the risks of conflagration and therefore roast pig.

Electric Light at Belvedere.—An installation has just been completed at the works of the Belvedere Company, Belvedere, Kent, the plant consisting of two dynamos (arc and incandescence), nine arc lamps and 110 (16 C.P.) glow lamps supplied by Messrs. Crompton & Co. There appears to be good scope for future business along the riverside, owing to there being an entire absence of gas in many places, oil lamps being the only alternative.

Electric Lighting Bills Withdrawn.—The promoters of the St. Martin's-in-the-Fields and the Strand Electric Lighting Bills have given official notice of their intention not to proceed further with these Bills during the ensuing session of Parliament. The only London Electric Lighting Bill now before Parliament (apart from provisional orders) is one promoted by the House-to-House Electric Supply Company for lighting the City.

Chatham Lighting.—At a meetingof the Chatham Board of Health on Friday (11th inst.), a deputation consisting of Mr. Jasper, Mr. Norman and Mr. Wingent, waited upon the board and requested that there should be a removal of the limitation to the consent as to the granting the electric lighting company a provisional order. The limitation fixed the period during which the company should carry on operations at twenty-one years, and the deputation wished that there should either be an absolute withdrawal or an extension of the limitation to forty-two years, as provided by the Act of 1888. The board referred the consideration of the matter to a committee.

Fire Sources.—There were 944 fires in Philadelphia during 1889, of which only four were due to electric lighting.

Electric Lighting of Madame Patti's Residence.—Adelina Patti's private theatre and winter gardens, at Craig-y-nôs Castle, are being lighted with the electric light, the installation of which has been entrusted to the Wenham Company, Limited, of London, the whole of the work being carried out by their own staff in the electrical department.

Gas to the Rescue.—Says a morning contemporary:—"The House of Commons one night this week was threatened with the danger of resuming the Session in partial darkness. An accident happening in the engine house of the company that partially supplies the electric light, considerably more than half the illuminating power was cut off. Notice was given to the resident engineer at so late an hour that it was impossible to generate out of the machinery belonging to the House a full supply of the electric light. The best that was possible was done under the circumstances. But it was found necessary in the dining room and other portions of the building to revert to the old gas supply, which had fortunately been kept in readiness.

The Molecular Telephone.—Mr. G. F. Shaver, Vice-President of the Shaver Corporation, manufacturers of the molecular telephone, has secured Mr. H. H. Warner, of patent medicine fame, as a partner. Mr. Warner has sold his medicine business to a syndicate for 5,000,000 dollars, and has bought a one-half interest in the Shaver concern at par, and will, says an American contemporary, "devote his great energies to pushing to a successful issue the business of the future competitor of the electric telephone."

The American Bell Telephone Company.—The annual report states the increase in the total number of instruments rented by the company to be more than 30,000, and the total number in use as 444,861. Fifteen new telephone exchanges were added, making a total of 757. The total mileage of wire is now 193,213, a gain of 23,000 during the year. Of this, 27,676 miles are underground. During the past year 1,838,913 dollars were paid in dividends, and 700,000 reserved for the depreciation account. According to the *Boston Herald*, the company has spent £1,000,000 in defence of its patents.

Edison Electric Light Company v. the United States Illuminating Company of New York.—The defendant company is one of the lessees of the Westinghouse Electric Company of Pittsburg, and the suit is brought for infringement of one of Mr. Edison's early patents on an electric meter embodying as its principal feature an electric motor, the speed of which is proportional to the current passing through it. The suit, says an American contemporary, has aroused considerable interest in electrical circles on account of its possible effects now that currents are so generally metered. The claims embodied in the patent are—(1), The combination with an electric circuit containing translating devices of an electric motor having a definite loading apparatus for registering the work done; (2), The combination of an electric circuit, an electromotor fan driven thereby, and a registering apparatus; (3), The combination of an electric circuit, an electromotor fan or blades driven thereby, a vessel or tank in which the fan blades are placed, and a registering apparatus; (4), The combination of an electric circuit, an electric motor, a fan or blades, a vessel or tank filled with liquid, in which the blades or fan are placed, and a registering apparatus; and (5), an electric meter consisting of a motor having a definite work to perform or loading to overcome and registering devices. It is alleged in the complaint that the well-known Shallenberger meter infringes the above claims.

Telephonic Extension.—The Newry correspondent of the *Dublin Express* says that the National Telephone Company, Belfast, is arranging to lay a trunk wire between Belfast and Dublin.

Foreign Trade.—The imports in March of copper ore amounted in value to £113,943, as compared with £112,364 in March, 1889; regulus and precipitate, £186,168, as compared with £306,880; and unwrought and part wrought copper, £184,504, as compared with £183,916. The imports of caoutchouc amounted to £338,016, as compared with £299,194; and of gutta-percha to £90,753, as compared with £29,113. The exports of unwrought copper were £162,468, as compared with £56,539; and of wrought copper, £69,631, as compared with £47,538. The value of the exports of telegraphic wires and apparatus connected therewith was £51,390, as compared with £285,993.

Telephony in Fiume.—The Hungarian Minister of Commerce has decided that Fiume is to have a telephone system, and work has begun.

Vaucluse.—An electric light installation has been completed at the Lunatic Asylum, Vaucluse. The work was done by the Maison Breguet, Paris.

The Telephone at Port Said.—By a contract dated December 31st, 1889, the Egyptian Minister of Public Works has authorised M. Sigmund Fahn to establish, at his risk and peril, telephonic communications in Port Said for a period of 15 years, with option of purchase by the Government after the tenth.

An Electric Tabulating System.—The Hollouth Electric Tabulating System, a description of which is given in the Journal of the Franklin Institute, is a device by which electricity is applied to the compilation and tabulation of census and other returns of a similar nature which require summation and classification under various heads and in different groups. The method consists essentially of in first recording the data relating to each person by printing holes in sheets or strips of paper, and then counting or tallying these data either separately or in combination by means of mechanical counters operated by electro-magnets, the circuits through which are controlled by the perforated strips. The system, which appears to be a thoroughly practical one, is estimated to effect a saving of nearly $580,000 if used in compiling the returns of the 11th census.

Ninety Miles in Eighty-Five Minutes.—The fastest run on record, says an American exchange, was made when a special passenger train covered the distance of ninety miles between Philadelphia and New York in eighty-five minutes. Our Great Northern Company, however, ran a train about a fortnight since 72 miles in one hour.

S.S. "Faraday."—This cable ship left the Albert Docks on the 15th inst., her destination being, we are informed, the repairs of the Jay-Gould Atlantic, which has been interrupted for a considerable period. It is reported, we know not with what truth, that the fault, or break, is in deep water.

A Great Electrical Trust.—According to the *Electrical Engineer*, N.Y., rumours are current in electrical circles of further amalgamations which would tend to eliminate a great part of the prevailing competition for business, as well as much patent litigation. The formation of a great electrical trust to absorb all the prominent electric light and power interests is spoken of, but our contemporary considers this unlikely, having regard to the complexity of the conditions which would have to be dealt with, amongst others the possibility of a new and radical discovery or invention in the production or distribution of electricity.

Overhauling Installation.—For overhauling and putting in working order present electric lighting installation, supplied new two seasons ago, for the Falcon Cliff Company, Douglas, Isle of Man. Tenders to include working and maintaining same for the season, June to September, 1890. Particulars from Secretary.

The Rating of Telephones and Wires: Important Decision.—The Brighton Recorder (Mr. Gates, Q.C.) delivered judgment at the Quarter Sessions on Monday in the appeal by the South of England Telephone Company, Limited, against the rating of their telephones and wires by the overseers of the parish of Brighton. The arguments were heard at the last sessions, when it was contended on behalf of the company that the assessment for the poor-rate of March 28th, 1889—viz., £650 gross and £500 rateable value—was excessive, and that the telephones were patented articles which they were licensed to use, that they were the property of the United Telephone Company and not of the appellants, and that they were chattels, and as such not liable to be rated at all. The Recorder now decided to dismiss the appeal and confirm the rate with costs. He pointed out that the appellant company had indisputably a rateable occupation by their wires, and he was of opinion that the instruments gave an enhanced value to the wires and the appellants' occupation in respect thereof. It was part of the apparatus which the hypothetical tenant would rent to make a profitable use of the wires. Upon the application of Mr. Besley, counsel for the company, the Recorder consented to state a case for a superior court on the question as to whether telephonic instruments are chattels or not.

Electrical Trades Section.—The annual meeting will be held at Botolph House on Monday next at 4 p.m.

The Institution of Electrical Engineers.—On Thursday next a paper will be read "On a Lightning Guard for Telegraph Purposes and on the Protection of Cables from Lightning," by Dr. Oliver Lodge, F.R.S., Member.

Electrical Welding.—At a meeting of the Institution of Civil Engineers, on Tuesday evening last, Sir F. Bramwell read a paper on "The Application of Electricity to Welding, Stamping, and other Cognate Purposes."

Explosion in the Bell Rock Lighthouse.—A very serious accident happened at the Bell Rock Lighthouse at 10 o'clock on Saturday night. It appears that there was recently fitted up at the lighthouse a cotton powder explosive signal. The charges of the cotton powder are connected by the wires of an electric fuse and detonator to an electric cable attached to a lever or jib fitted to the roof of the lighthouse, the cable being laid along and through the roof to a small magneto-electric machine placed inside the light-room. These charges consist of small cylindrical discs of dry cotton powder coated with paraffin, and having a small hole up the centre to receive the detonator, which is a copper tube containing fulminate composition. On Saturday night the weather was thick, and accordingly after dark the signal was fired, the preparation of the signals taking place in the light-room, and the firing from the balcony. At 10 o'clock one of the signals exploded prematurely, or, at all events, the explosion had the effect of demolishing the dome of the lighthouse, which is the light-room. The lighting machinery, which is also for ringing the two large fog bells, was destroyed, and the lights were extinguished. The dome of the lighthouse with the machinery is a wreck, but the tower itself is not supposed to have sustained any damage. Later particulars show that the fog signalling firing was commenced on Saturday night at 9 o'clock, and was continued every 10 minutes till 10.20. It is understood that at that hour one of the cartridges did not explode, the jib was lowered, and the unexploded cartridge removed, and a fresh cartridge put on, but, unfortunately, as appears, without the electrical current being disconnected, the result being that the explosion took place before the jib could be raised again. The whole of the windows in the light-room were blown out, all the internal fittings are smashed, and the framework of the room is damaged, but the dome, which is of copper, is entire. The machinery for revolving the light and the lenses and reflectors have not yet been examined, but it is supposed that the machinery is not greatly damaged.

Theft of Telephone Wires.—Ebenezer Ledger, 12, of 6, Robert Street, Woolwich; John Roberts, 11, of 2, Joseph Street, Woolwich; and Charles and Albert Goldsmith, aged respectively 12 and 11, of 18, Siemens Road, Woolwich, were charged at Woolwich Police Court with stealing a quantity of copper wire, value £2 10s., from the telephone posts on Cox's Mount, Charlton, the property of the National Telephone Company. Mr. Augustus Calder, of 3, Southwark Street, manager of the third district of the company, said that between the 2nd and 9th of April 16 spans of copper telephone wire, forming a portion of the line connecting London and Woolwich, were stolen, at a point where it passes over the sand-pits at Charlton. Altogether 80 lbs. of copper, worth 8d. per pound, had been carried off. The company had about a dozen subscribers at Woolwich who had been seriously inconvenienced by having their telephonic communication cut off. The repairs had cost the company about £50. On Tuesday, the 15th, the accused were brought up again, when the Magistrate, Mr. Marsham, said the prisoners had caused an amount of injury out of all proportion to their gain, and he must make an example to keep others from the like temptation. Albert Goldsmith, being young, would be discharged; but the others would be sentenced each to six strokes with a birch rod. The parents of the boys were invited to witness the punishment, which was inflicted by the gaoler in the station yard. The two marine store dealers, Mary Ann Dandridge, of High Street, and Jane Town, of Morris Street, Woolwich, were then called to answer summonses charging them with purchasing less quantities of copper than 56 lbs., contrary to the Prevention of Crimes Act, 1871. One of the boys was called to testify against them, and they both admitted that they might have bought small quantities of the wire and forgotten the circumstance. Mr. Marsham fined Mrs. Town £2, and Mrs. Dandridge £5.

A Modest Rate for Electric Lighting.—The cry of the excessive cost of electric lighting for street purposes raised in some quarters has not terrified the inhabitants of the little suburban village of Weybridge. They assembled last Thursday evening to receive the accounts of the lighting inspectors and to determine the amount to be raised for public lighting during the coming year. The accounts showed that £230 had been received by the inspectors from the overseers; and there remained a balance in hand of £205. One of the inspectors, Dr. Sealy, estimated that as they would require £260 for next year's lighting, a 2¼d. rate would produce £264. The inspectors, he said, proposed to fix 10 or 12 additional lamps during the year. He claimed that, in providing the electric light for the modest rate of 2¼d. in the pound, they had achieved a good deal. There has been some agitation in the place against the electric lighting poles, which are described as "unsightly," and Dr. Sealy informed the meeting that the cost of putting the wires underground would be £200 per mile, inclusive of the lamp-posts, which would cost about £1 10s. each. They had about six miles over which the lighting extended, and there were 18 lamp-posts per mile. The contractors had offered, if the parish constructed the necessary earthenware conduits, to put in the wires and remove the present poles and overhead wires, without additional cost. It was agreed that a rate of 2¼d. in the pound should be levied. A suggestion was also made that a subscription list should be opened for placing the wires underground; the sum which would be required being from £1,200 to £1,500. No move, however, was made in the matter.

The Southwark Electric Railway.—We are informed that the experimental runs of the two trial locomotives have now been completed and that the plant has been removed. It will be evident from this that the details of the whole system have been settled and that very little will be heard of the railway until the time arrives for its inauguration.

The Silvertown Dry Cell.—This cell, which is manufactured by the India-rubber, &c. Company at Silvertown, has been designed for use where the battery is liable to shaking or rough handling; such as on board ship, for field telegraphy, and similar work, where it would be found inconvenient to use the ordinary cells. As the cell is self-contained, and delivered ready for use, it is only necessary to couple it up in the usual way, no addition of solution being needed. It possesses all the advantages of the Leclanché cell, with the additional one that it may be used in almost any position, there being no liquid in it to spill. Care should be taken in mounting a battery of these cells to prevent one cell from touching another, and they should stand upon a base of some insulating material, such as glass, or dry wood, &c., and for efficient working, this cell should not be used in positions where the temperature is high. When the cell appears to have been worked out, it is as a rule only necessary to fill it up with a saturated solution of sal-ammoniac, and let it stand for some time, when the solution may be poured out, and the cell wiped dry at the top; it will then be found to have recovered.

Improved Secondary Battery.—We understand that a new secondary battery will shortly be introduced by an English inventor, who claims that his accumulator will be equally suitable for lighting and traction purposes, that the price will be about half that of the E.P.S. cells, and that it will be much more efficient than the latter. If these claims can be substantiated, considerable development in accumulator traction may be expected to take place. We hope to be able to give some details regarding this battery in a future issue.

The Royal Society.—Yesterday a paper was read by Profs. Rücker and Thorpe, F.R.S., entitled, "Preliminary Note on Supplementary Magnetic Surveys of Special Districts in the British Isles."

Electricity Extraordinary.—There is a certain amount of excuse for the daily Press making blunders in technical matters; but journals which profess to be of a scientific nature should be careful in their paragraphs. We extract the following from a technical contemporary:—"It is estimated that it will require the labour of 2,000 men 54 years to extract all the coal from the territory between Reynoldsville and Sykesville, in the Punxsutawney, Penn., region. It will be drawn out by electric cables, and the mines brilliantly illuminated by electric lights." The use of electric conductors for hauling purposes is novel, to say the least.

Electric Railways in German Mines.—The Allgemeine Electricitäts Gesellschaft, of Berlin, have built at their own expense an electric railway in the Richter Pit of the Laurahütte, and the Deutschen Electricitätswerke zu Aachen are adopting a similar course at the Antonienhütte.

A Song with Words.—

(*Suggestively dedicated to Lord Bury.*)

Oh! tell me not that you will "clic"
When I can but "electricate,"
Or, "propelected," merely "tric"
A distance I might well "volate."
For if to "Faradate" or "Volt"
In "motored" motion I may "glide,"
I wonder why I may not "bolt,"
When called on to "electricide."
Yet as each word I clip and splice,
I'm more than half inclined to "trice."

Let others "elk" until they're wild,
I will not "lectroceed" or "glint,"
And though their trip be "poled" or "piled,"
I need not "coil," or "spark," or "scint."
No, if "electroflected" force
They use to "clash" along their way,
I p'raps might "ohm" upon my course,
Or even "squirm," if "clicked" to day,
But no! The *Times* gives sound advice.
As matters stand, I think I'll "trice!"—*Punch.*

Wanted a Word.—Says the *St. James's Gazette*:—"We have received the following from a correspondent who has some reputation as a linguist:—Lord Bury must be disappointed with the suggestions which have been made in reply to his demand for a word to express motion by electricity. 'Vril' is perhaps the least objectionable, but it is not good. I think I can help his lordship to a better word from the tongue of the Jsjtikolo, an interesting race dwelling on the other side of the lower end of Lake Znkbeo, in latitude 111 S. The Jsjtikolo, though somewhat addicted to eating their superfluous relatives, and wholly devoid of any prejudice in favour of speaking the truth, have attained a high degree of morality and civilisation. Their language is extraordinarily rich, as may be imagined from the fact that they have twenty-seven words for 'breaking a commercial contract" and no less than ninety-one for various methods of 'maiming dumb animals.' A well-known traveller has recorded his regret that Mr. Gladstone was not born in this tongue, as he would then have possessed an instrument capable of giving fit expression to the workings of his enormous mind. The word which I propose to adopt is *mbspplmtnzbjptl*. Its literal signification is 'to proceed rapidly (or with speed) upon a pie-bald horse;' and the analogy between this idea and that suggested by Lord Bury is obvious, and (I venture to think) rather happy. We should say, then, 'We mbspplmtnzbjptled in our launch from Pimlico to Hammersmith.' As the Jsjtikolo, like the German and ancient Greek, delights in many derivatives from a single root, a very slight modification of the verb gives us the substantive form; and we should say, 'the jjgrmxlbt by road from East Dulwich to Peckham lasted two hours.' I flatter myself that this word is preferable to any others that have yet been suggested; and, further, I claim for it two special advantages: it is not likely to be confounded with any existing English word in common use, and it is, when properly pronounced, practically a monosyllable.

Light Comparison.—The *Contract Journal*, in an article on the electric lighting of Chelmsford, goes somewhat out of its way to discredit gas. Says our contemporary:—"Reckoning each old gas lamp as equivalent to 16 candles, the total candle-power was only about 3,000 candles. Reckoning the new illuminant at only one-half its nominal candle-power we get over 20,000 candles, or seven times the amount of light at about one-seventh more cost. Assuming that each lamp gives its nominal candle-power, you get 14 times as much light." To argue in such a manifestly absurd fashion by taking in a few arc lamps of 2,000 candle-power each to total up a large illuminating power does no good, but rather harm, to the electric lighting industry. We might just as well erect a 20,000 candle-power arc lamp in the market-place of a town and argue in the same fashion, but still it would not represent the general lighting of the township. Let us be fair above all things, for electric lighting will eventually take its place in the world's industries on its own merits.

Electricity in the States.—The Committee of the New York Senate on General Laws has reported unfavourably on overhead high tension systems in New York or in thickly populated districts. It suggests that underground construction should be used in all cities with a population of 125,000 and upwards. The committee sets the limit of a safe current at 250 volts. As regards high and low tension, it is of opinion that either may be used with safety by means of proper and reasonable precautions.

Correction.—With reference to a note which appeared in our last issue, Messrs. Davey, Paxman & Co., inform us that they are providing the whole of the steam engines and boilers required for driving the electric light at the Royal Military Exhibition, but the dynamos and other electrical apparatus are being supplied by the Laing, Wharton & Down Construction Syndicate, of New Bond Street, London.

Battery Resistance.—With reference to the experiments of M. Paul Bary, in which it is shown that the resistance of a battery changes according to the current drawn from it, M. Uppenborn criticises the figures and states that they are a good deal too high. Moreover, he argues that the method of making the tests cannot give satisfactory results. M. Uppenborn gives certain figures to prove his case, but it is not stated by what instrument, nor the exact manner in which the tests were made, and in the absence of these we hesitate to accept his conclusions.

Accumulators.—Mr. W. J. S. Barber Starkey writes to us as follows:—"My accumulators have been lying idle since last June, and the level of the electrolyte in the cells is apparently higher than it was when they were last charged, showing that nothing has been lost through evaporation. The cells contain dilute sulphuric acid, to which a certain amount of carbonate of soda was added. *It is a fact* that cells containing sulphate of soda *do not* suffer in the same way from evaporation as cells containing simply dilute sulphuric acid, but why this is the case I do not understand. The *s. g.* of the electrolyte is now 1,150, and the E.M.F. of each cell is from 1 and $\frac{7}{10}$th to 1 and 9½ tenths of a volt; no signs of sulphating are perceptible. I venture to send you the above in case you may consider it of any interest."

Personal.—We hear that Mr. P. J. Bordessa has resigned the secretaryship of the Telegraph Manufacturing Company, a position he has held for several years past. In recognition of the very high esteem in which Mr. Bordessa was held by the staff, a valuable silver-mounted walking-stick was presented to him on leaving, together with an address expressing sincere regret at his resignation, and wishing him every success and prosperity in the future.

Telegraphists' Grievances.—On Tuesday night in the House of Commons Lord Compton called attention to the position of the Post Office telegraphists in London and the provinces, and moved a resolution (which was seconded by Baron F. de Rothschild) advocating the redress of their grievances. He complained in particular of the hours of their employment, which, he maintained, were too long, and of the inadequacy of their pay and allowances, and urged that more satisfactory arrangements should be made with regard to classification and promotion and meal times. Mr. Raikes thought the present was not an opportune moment for bringing forward the subject, as he had as yet received no communication from the London telegraphists beyond a request that he would receive a deputation; but with regard to the provincial officers he had appointed a strong departmental committee, with a representative of the Treasury on it, who would carefully deal with those grievances which it was possible to consider. Sir A. Borthwick opposed the motion on the ground that Parliament ought not to interfere between the Government and the Civil Service. Sir L. Playfair expressed satisfaction at what he regarded as a conciliatory reply of the Postmaster-General, and after some remarks from Mr. P. Morgan, Mr. Redmond, and Dr. Tanner, the motion was negatived by 142 to 103.

The Telephone in Paris.—The working of the telephone in Paris does not appear to have been made any better by passing from the company into the hands of the Government. Loud were the public complaints against the company on the eve of the expiration of their concession, and louder they appear to be under the new administration. A few weeks ago the authorities claimed that the "influenza" had disorganised the service, the female operators having suffered greatly from the epidemic; the same excuse is no more available, and the new Postmaster-General will have to do something towards giving the ratepayers and subscribers satisfaction.

Train Lighting in Switzerland.—The application of electricity for the lighting of railway trains is a problem which yet remains to be satisfactorily solved; but, notwithstanding this, many experiments are being conducted in various localities to arrive at a definite decision. The most recent to take up this subject were certain Swiss engineers, who have been making comparative tests with the electric light, oil lighting, and the Pintsch system of gas lighting. The experiments took place in a carriage attached to a passenger train which travels between Zurich and Richtersweil. The carriage contained one first class and two second class compartments, and a toilet cabinet. One incandescent lamp was suspended from the middle of the roof of each compartment, and one glow lamp was also placed on each platform at the ends of the car, the two latter lamps being only in circuit when passengers entered or departed from the carriage. The battery was placed in a box under the floor of the vehicle, and weighed 3 cwts. It consisted of eight cells, and contained sufficient energy to last for 18 hours, when it had to be recharged. The results obtained from the experiments were that a 6 C.P. glow lamp is equal to an ordinary oil lamp; but this was considered to be insufficient. A 10 C.P. incandescent lamp, however, enabled the passengers to read with facility small newspaper print when the lamp was provided with a good reflector.

Portuguese Military School of Engineering.—The practical school of engineering attached to the Portuguese military establishment, has issued its programme for 1890. Among the various works and exercises to be undertaken by the students, we notice that the following course is prescribed for the telegraphic corps: —*Permanent Telegraph Lines*—1. Construction, repair, defence and destruction of a permanent line. 2. The fitting up of stations; Breguet instruments being employed. *Field Telegraph Lines.*—1. The laying down and removal of overhead and ground lines. 2. The establishment and removal of a telegraph line at river crossings. 3. The laying down and removal of lines to advanced posts. 4. The fitting up and dismounting of terminal and intermediate telegraph stations. The reception, transmission and interception of messages. 5. The fitting up and dismounting of stations at advanced posts furnished with telephonic and acoustic apparatus. *Optical Telegraphy.*—1. Communication by means of flags, &c. The fitting up of intermediate and distant stations. Communication by means of the Mance heliograph. 2. Communication by lamps, with the Mangin heliograph, and with the photo-electric apparatus.

Executions by Electricity.—The *Electrical World*, N.Y., trusts that for the sake of the electrical industry the electrical execution law will be abolished.

Bernstein Lamps.—The manufacture of these lamps is being introduced into France by M. Cadiot.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Liverpool Electric Supply Company, Limited.—The annual return of this company, made up to the 21st ult., was filed on the 10th inst. The nominal capital is £200,000 in £5 shares, the whole of which are taken up. Upon 10,000 shares the full amount has been called, and £2 per share upon the remaining 30,000. The calls paid amount to £107,428, and unpaid to £2,572. Registered office, 15, Highfield Street, Liverpool.

Midland Electric Light and Power Company, Limited.—The annual return of this company, made up to the 4th inst., was filed on the 10th inst. The nominal capital is £50,000 in £10 shares, 157 shares are taken up, 150 of these being considered as paid up. Upon the remaining shares the full amount has been paid up.

Henley Telegraph and Electric Construction Company, Limited.—The statutory return of this company, made up to the 4th ult., was filed on the 11th inst. The nominal capital is £200,000 in £10 shares. 105 shares are taken up, and the full amount has been called thereon. The calls paid amount to £721, and unpaid to £329. Registered office, 6, Clement's Lane, Lombard Street.

Newcastle-upon-Tyne Electric Supply Company, Limited.—The annual return of this company, made up to the 31st ult., was filed on the 10th inst. The nominal capital is £50,000 is £5 shares; 3,000 shares are taken up, and £4 per share has been called thereon. The calls paid amount to £11,460, and unpaid to £540.

Schaefer's Patent Etching Company, Limited (metal-plating by galvanic action).—The statutory return of this company is made up to the 6th August, 1889, and was filed November 13th, 1889. The nominal capital is £10,000 in £1 shares; 4,707 shares are taken up, 200 of which are considered as fully paid. Upon 207 shares 10s. per share has been called, and at the date of making up the sum of £3 10s. had been paid in calls; £100 remaining unpaid. Registered office, 28, Essex Street, Strand.

NEW COMPANIES REGISTERED.

Friedenthal and Company, Limited.—Capital £20,000 in £10 shares. Objects: To carry on business as marine, mechanical, electrical and general engineers, and for such purposes to adopt an unregistered agreement of December 19th, 1889, between Frederick Friedenthal and Nathaniel Nutler. Signatories (with one share each), Robert Wilkins, T. H. Clarke, J. Starkie, F. Friedenthal, W. N. Newsholme and James Clarke, all of Preston, Lancashire. Directors' qualification 25 shares. Registered 14th inst., by Hooper and Son, 69, Ludgate Hill.

CITY NOTES, REPORTS, MEETINGS, &c.

The Indo-European Telegraph Company, Limited.

THE directors' report for 1889 shows that the revenue from all sources for 1889 amounted to £108,288 15s. 5d., as compared with £110,327 7s. 7d. for 1888, showing a decrease of £2,038 12s. 2d.

The expenses were: on commercial and general account, £28,637 9s. 3d.; on maintenance account, £30,602 17s. 6d., including £733 5s. paid to the Russian Government; total £59,240 6s. 9d., as against £52,393 4s. 7d., for 1888, an increase of £6,847 2s. 2d.

Deducting the above expenses, taking credit for £6,783 18s. 7d., brought over from 1888, and debiting income tax, there remains the sum of £54,535 10s. 3d.

From this amount £10,000 has been placed to reserve, and that sum, together with £10,625, amount of interim dividend, have to be deducted, leaving a balance of £33,910 10s. 3d.

The directors now propose the declaration of a dividend, for the six months ending December 31st, of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent. for the year, and a bonus of 20s. per share, both free of income tax, making in all 10 per cent., carrying forward £2,035 10s. 3d. to the credit of 1890.

It will be remembered that the balance brought over from 1888 was larger than usual, because as then stated "Provision has to be made for extensive alterations and additions to the system which must be effected during the current year, and the recent interruption of both the company's cables in the Straits of Kertch has also entailed exceptional outlay, so that the whole of the additional amount carried over will be absorbed." The amount carried over was £6,783 18s. 7d., and the additional expenditure, as appears under "maintenance," £6,847 2s. 2d.

The falling off in the revenues derived from Indian messages upon the reduction of tariff remarked upon in 1887 and 1888, continued during 1889, but fortunately has again for the most part been made up by other traffic.

The International Telegraph Conference will meet at Paris in May next. The company will be represented as heretofore by the managing director.

The following directors retire by rotation, and offer themselves for re-election:—C. Holland, Esq., and H. H. Meier, Esq.

The Eastern Extension, Australasia and China Telegraph Company, Limited.

THE directors' report for the half-year ended 31st December, 1889, and which will be submitted at the general meeting to be held on April 23rd, 1890, shows that the gross receipts, including Government subsidies, have amounted during that period to £264,103 12s. 11d., against £238,854 14s. 4d. for the corresponding half-year of 1888.

The working and other expenses, including £24,620 10s. 2d. for cost of repairs to cables and expenses of ships, absorb £73,498 19s. 3d. against £71,519 7s. 4d. for the corresponding period of 1888, leaving a balance of £190,604 13s. 8d. From this is deducted £2,864 15s. 11d. for income tax, £41,595 for interest on debentures and contributions to sinking funds, and £1,386 7s. 3d. for additions to staff quarters, leaving £144,758 10s. 6d. as the net profit for the half-year, which, with £26,236 1s. 8d. brought forward, shows an available balance of £170,994 12s. 2d.

One quarterly interim dividend of 1¼ per cent. has been paid for the half-year, and it is now proposed to distribute another of like amount, making, with the interim dividends paid for the first half-year a total dividend of 5 per cent. It is also proposed to pay a bonus of 4s. per share or 2 per cent., making a total distribution of 7 per cent. for the year 1889. The balance of £58,494 12s. 2d. has been carried to the general reserve fund, which, after being credited with the interest on investments received during the half-year, and a surplus profit resulting from a careful re-valuation of the spare cable and stores in hand, and debited with £76,461 10s. 11d. on account of the cost of the Western Australian cable, and further partial renewals of the Hong Kong-Saigon cable, now stands at £710,113 15s. 10d.

In pursuance of the conditions upon which the issue was made, the balance of 125 of the company's 5 per cent. debentures (1880) was drawn by lot on the 10th ultimo for payment at par on the 1st July next.

Three hundred and five of the company's 5 per cent. Australian Government subsidy debentures were also drawn by lot on the 1st instant, for payment at par on the 1st July next.

The subsidy agreement with the Government of the Straits Settlements in respect of the Malacca-Singapore-Penang cables expired in August last, and a fresh arrangement has been entered into for a reduced subsidy of £400 per annum, payable for an additional 5 years.

Several cable interruptions occurred on the company's system during the half-year under review, but, as nearly all the cables are duplicated, the traffic was not materially affected, except between Australia and New Zealand, where telegraphic communication was entirely suspended from the 7th to the 20th August. This caused some dissatisfaction in the Colonies, and, although a second cable is not required for the traffic, the existing line being more than equal to its transmission, your directors at once decided, with the approval of the Governments of New Zealand and New South Wales, to duplicate the Sydney-Nelson cable, so as to prevent, as far as possible, any further inconvenience to the telegraphing public. A contract was accordingly entered into with the Telegraph Construction and Maintenance Company for carrying out the work, and the cable has been manufactured and shipped, and is expected to be laid by the end of the present month.

In consequence of the frequent interruption of the Madras-Penang section off Penang and in the neighbourhood of the Nicobar Islands, where the ground over which the line passes is very rocky and uneven, and to avert, as far as possible, the danger of total interruption of telegraphic communication with the far East which would result from the failure of the Madras-Penang cable simultaneously with the Rangoon-Penang cable, your directors have decided to renew a considerable portion of the Madras-Penang section, laying the new cable along a more favourable course to the south of the existing route. A contract has been made with the Telegraph Construction and Maintenance Company for the manufacture and laying of the necessary cable, 650 nautical miles in length, and it is hoped that the operation will be completed before the next south-west monsoon sets in.

All the company's cables are now in good working order.

In accordance with the articles of association, Charles William Earle, Esq., and Sir Thomas Fairbairn, Bart., retire by rotation, and, being eligible, offer themselves for re-election.

The retiring auditors, Mr. Henry Dever and Messrs. Welton, Jones & Co., also offer themselves for re-election.

Montevidean and Brazilian Telegraph Company, Limited.

THE following report for the year ending 31st December, 1889, has been issued.

The percentage of gross revenue receivable from the Western and Brazilian Company shows a slight increase, being £3,783 11s. 4d. as compared with £3,604 4s. 2d., in 1888.

As the expenses for the year have been materially reduced, mainly because of the substitution of debentures bearing interest at the rate of 6½ per cent. per annum for the former 8 per cent. debentures, the balance to the credit of the revenue account is larger than that for any year since 1877—when the balance amounted to £2,344 15s. 6d. as compared with £1,958 19s. 5d. for 1889. But in 1887 only £500 was applied in redemption of debenture (instead of as now £1,000) and the large balance of £1,515 was brought forward from 1876. The percentage of earnings for 1877 amounted to £3,272 as compared with £3,783 for 1889.

The directors recommend the payment of a dividend at the rate of 4s. 6d. per share on the preference shares of the company, which will absorb £1,870 13s. leaving a balance of £88 6s. 5d. to be carried forward to next account.

The general meeting of the company was held at the company's offices, 2, Tokenhouse Buildings, London, E.C. yesterday, but our representative was refused admission.

Submarine Telegraph Company.

SIR J. GOLDSMID, Bart., M.P., presided on Tuesday afternoon, at the offices, 2, Throgmorton Avenue, over a meeting of the shareholders in this company.

In proposing the adoption of the report of the liquidators, the Chairman, said that the liquidation had taken a great deal of time. The offer made to them by the English and French Governments was very inadequate, and after much trouble the liquidators obtained some increase on the terms originally offered. They had been enabled to repay to all the shareholders the original amount of their investment in the company, which, considering the circumstances, he did not think was unsatisfactory. They now proposed to give them a further 7 per cent. on the capital stock. The total amount now outstanding was a little over £5,000, out of which they would have to pay the remaining expenses of the liquidation, &c., and the return which would be made to the shareholders on the final liquidation would be 1 per cent. Altogether, therefore, the shareholders would receive £108 for their £100 stock.

The Hon. H. R. Brand seconded the motion.

In the discussion which followed complaint was made of the action of the directors in not taking the proprietors into their confidence the moment they found that a renewal of the concession was not to be granted by the English and French Governments.

In reply, Mr. Brand said that up to within about six days of the time when the English Government interposed, the directors had every confidence that they would succeed in obtaining a renewal of the concession, and they had deliberately kept things secret on that account. The liquidation had been forced on them. The directors took the proprietors into their confidence as soon as the negotiations for a renewal of the concession actually failed.

The report was adopted, and £1,000 was awarded to the liquidators as remuneration.

Reuter's Telegram Company, Limited.

The report to be presented at the 26th ordinary general meeting of the shareholders, to be held at the company's offices, 24, Old Jewry, E.C., at noon, on Wednesday, the 23rd inst., states:—The directors beg to report that the net profits for the year ending 31st December last, after payment of current expenses, and deducting rebate on unexpired subscriptions, amount to £6,703 10s. 6d., including £446 1s. 7d. brought forward from the last account. An interim dividend of 4s. per share was paid in October last, and the directors now declare a further dividend of 6s. per share, making a total distribution for the year of 6¼ per cent. free of income tax. This will absorb £4,590 6s., and after adding £2,000 to the reserve fund there will remain a balance of £113 4s. 6d. to be carried forward. The dividend warrants will be payable on the 26th inst. The important negotiations which were pending at the time of the last general meeting have been brought to a satisfactory conclusion, and the directors have pleasure in announcing that the friendly arrangements between the company and the leading Continental news agencies, which expired in February last, have been renewed for a prolonged period. The directors regret to have to announce that Mr. Frederick J. Griffiths, owing to ill-health and a heavy bereavement, has resigned the secretaryship of the company. They have accepted his resignation with reluctance, in order to relieve him of the routine duties of the post, but they have arranged to retain him on the staff. Mr. Walter F. Bradshaw, the assistant-secretary, has been appointed his successor. In conformity with the articles of association, the Hon. Mark F. Napier retires from the direction, but offers himself for re-election. Messrs. Welton, Jones & Co. offer themselves for re-election as auditors.

The Western and Brazilian Telegraph Company, Limited.—The directors yesterday decided, after placing £7,500 to the renewal fund and £5,600 to the debenture redemption fund, to recommend at the forthcoming meeting, a dividend of 6s. per share, making, with the previous dividend, a distribution of £4 per cent. for the year, carrying forward £3,751.

West India and Panama Telegraph Company, Limited.—The directors recommend that a dividend of 6s. per share on the first preference shares, to December 31st last, and 27s. 6d. per share on account of arrears on the second preference shares, be declared, leaving £516 to be carried forward.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 11th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,964.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (April 10.)	Closing Quotation. (April 17).	Business done during week ending April 1, 1890	
£					Highest.	Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	98 —101	98 —101		
1,549,160	Anglo-American Telegraph, Limited	Stock	49 — 50	48⅞— 49⅛ xd	49½	49
2,725,420	Do. do. 6 p. c. Preferred	Stock	83½— 84½	83 — 84 xd	84¼	82⅛
2,725,420	Do. do. Deferred	Stock	14 — 14½	14 — 14½	14⅛	12⅝
24,000	Australasian Electric Light, &c., Limited, Nos. 1 to 24,000 ...	5	... ...	... ...		
130,000	Brazilian Submarine Telegraph, Limited	10	12¼— 12⅜	12¼— 12⅜	12⅜	12 5/16
99,000	Do. do. 5 p. c. Bonds...	100	100 —102	100 —102	102½	...
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	104 —107	104 —107		
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416... ...	3	2¼— 2½	2¼— 2½	2¼	...
63,416	Do. do. Preference, Nos. 1 to 63,416 ...	2	1⅝— 1¾	1⅝— 1⅞		
224,850	Consolidated Telephone Construction and Maintenance, Ltd. ...	14/-	½— ⅝	½— ⅝		
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5¼— 5⅜	5¼— 5⅜		
16,960	Cuba Telegraph, Limited	10	11 — 11½	11 — 11½		
6,000	Do. do. 10 p. c. Preference	10	17½— 18½	17½— 18½		
12,931	Direct Spanish Telegraph, Limited ... (£4 only paid)	5	3¾— 4¼	3¾— 4¼		
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10		
60,710	Direct United States Cable, Limited, 1877	20	10½— 10⅝	10 — 10½ xd	10 5/16	10 1/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14 — 14½	14 — 14¼ xd	14⅛	14
70,000	Do. 6 p. c. Preference	10	14⅞— 15¼	14½— 15 xd	15⅛	14 11/16
200,000	Do. 5 p. c. Debs. (1877 issue), repay. Aug., 1899	100	106 —109	106 —109		
1,200,000	Do. 4 p. c. Mortgage Debenture Stock	Stock	107 —109	108 —110		
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	14⅛— 14⅜	14⅛— 14½	14 9/16	14¼
320,000	Do. 6 p. c. Debentures, repay. February, 1891	100	100 —102	100 —102		
446,100	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. ...	100	102 —105	103 —106	103	...
12,500	Do. 5 p. c. Debentures, 1890, redeem. ann. drawings ...	100	100 —102	100 —102		
367,900	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900...	100	101 —104	101 —104	102⅞	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4⅜— 5⅛	4⅜— 5¼		
46,700	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	5⅛— 6	5 — 5⅛ xd	5 1/16	5
19,700	Fowler-Waring Cables, Nos. 301 to 20,000 ...(£3 only paid)	5	2¼— 2⅜	2¼— 2⅜		
180,227	Globe Telegraph and Trust, Limited	10	8⅜— 8⅞	8⅜— 8⅞ xd	8⅞	8⅜
180,042	Do. do. 6 p. c. Preference	10	14⅝— 14⅞	14⅝— 14⅞ xd	14⅞	14 13/16
150,000	Great Northern Tel. Company of Copenhagen	10	15½— 16	15½— 16	16	...
40,000	Do. do. 5 p. c. Debs. (issue of 1881) ...	100	100 —103	102 —105		
250,000	Do. do. do. (issue of 1883) ...	100	104 —107	104 —107		
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000 ...	10	12 — 13	12 — 13		
5,334	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11 — 12	11 — 12		
41,600	India-Rubber, Gutta-Percha and Telegraph Works, Limited ...	10	17½— 18½	18 — 19	18¼	17¾
200,000	Do. do. 4½ p. c. Deb., 1896...	100	102 —104	103 —105		
17,000	Indo-European Telegraph, Limited...	25	41 — 43	41 — 43	42¾	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7		
100,000	Do. do. do. 6 p. c. Debentures ...	100	106 —109	106 —109		
49,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000 ...	10	5½— 6	5½— 6		
386,875	National Telephone, Limited, Nos. 1 to 386,875	5	5 — 5⅛	5⅛— 5⅜	5 5/16	5⅛
49,825	Do. New Nos. 386,876 to 436,700 (£4 only paid)	5	3⅞— 4¼	3⅞— 4⅛	3 15/16	3⅞
15,000	Do. 6 p. c. Cum. 1st Preference	10	12 — 12½	12¼— 12⅝		
15,000	Do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	9½— 10⅛	9⅝— 10½	9¾	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	¼— ⅜	¼— ⅜		
9,000	Reuter's, Limited	8	7 — 7¾	7½— 8	8	7⅝
209,750	South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	¼— ⅜	¼— ⅜		
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	3¼— 3⅜	3¼— 3⅜		
3,381	Submarine Cables Trust	Cert.	112 —117	110 —115		
78,949	Swan United Electric Light, Limited ... (£3½ only paid)	5	... ...	4⅛— 5		
37,350	Telegraph Construction and Maintenance, Limited	12	44 — 46	44 — 46 x	45½	41¼
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 — 104		
55,000	United River Plate Telephone, Limited	5	4⅛— 5	4⅛— 5		
146,000	Do. do. 5 p. c. Debenture Stock... ...	Stock	90 — 94	90 — 94		
100,000	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...		
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	9½— 10½	9½— 10½		
300,000	Do. do. do. 5 p. c. Debentures	100	98 —101	98 —101	101	99¾
30,000	West Coast of America Telegraph, Limited	10	9½— 10½	9½— 10½		
150,000	Do. do. do. 8 p. c. Debs, repay. 1902 ...	100	121 —126	121 —126		
64,572	Western and Brazilian Telegraph, Limited	15	10⅜— 11¼	10½— 11	11⅛	10⅞
26,986	Do. do. do. 5 p. c. Cum. Preferred	7½	6¼— 6⅜	6¼— 6⅜		
26,986	Do. do. do. 5 p. c. Deferred	7½	4¼— 4⅜	4¼— 4⅜	4⅜	4¼
200,000	Do. do. do. 6 p. c. Debentures "A," 1910...	100	106 —109	106 —109		
250,000	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106		
88,321	West India and Panama Telegraph, Limited	10	3⅛— 3⅜	2⅞— 3⅛	3⅛	2⅞
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11⅛— 12	11⅛— 12	12	11⅞
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	14 — 15	14 — 15		
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	$1,000	122 —126	122 —126		
179,300	Do. do. 6 p. c. Sterling Bonds	100	99 —101	99 —101		
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£2 only paid)	5	1¾— 2¼	1¾— 2¼		

* Subject to Founders Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 6¾—7¼.—Electric Construction Corporation (£10 paid), 9⅝—10¼.—House-to-House Company (£5 paid), 5—5¼.—London Electric Supply Corporation, Ordinary (£5 paid), 2⅝—2¾.—Manchester Edison and Swan Company, £9, (£1 paid), 11/- —12/-.

ENGLISH AUTHORITIES ON HIGH TENSION UNDERGROUND CIRCUITS.

DURING the recent sessions of the New York Senate Committee, which inquired into the condition of the electric lighting circuits in New York City, there were submitted to it the answers given by a number of prominent English electricians to a series of questions, relating to the practicability and safety of underground high tension circuits. These questions were prepared by Prof. Henry Morton, and the answers to them are on file in the Stevens Institute of Technology. As the questions are of general interest at this time, we print them below together with the answers given to each:—

Q. 1. Can high tension direct and alternating currents for lighting and power purposes be safely and successfully distributed by means of underground cables? If so, up to what voltage can this be done?

Sir WILLIAM THOMSON: Yes, I believe so, up to 2,500 volts.

Prof. GEORGE FORBES: We have ample proof that high pressure electric currents, either direct or alternating, can be distributed safely and successfully, for lighting purposes, by means of underground cables. Our experience in the past has been limited to 2,500 volts, as a maximum, and up to this pressure there has been no difficulty whatever, in any case where care has been taken to secure a good and durable type of insulation to the conductors, and to protect them from mechanical, chemical, and other sources of deterioration. It would be unwise to hazard an opinion as to the highest pressure which can be properly used in underground electric mains, until we have experience to guide us. While we have ample data as to insulation and durability under ordinary conditions, yet there are certain phenomena, of whose existence we are aware, when very high pressure (say 10,000 volts) are used, which may, or may not, create difficulties with these high pressures. Until we have further experience, I would not advise anyone to run the risk of making the supply of current irregular through defective insulation, and for this reason I would not recommend, at this date, the use in underground mains of a higher pressure alternating current than 2,500 volts, except in way of experiment.

Dr. JOHN HOPKINSON: It has been conclusively proved that alternating high tension currents can be supplied without inconvenience by means of underground conductors if the work is properly done; it has also been proved that this can be done with a potential of 2,400 volts. So far as I know it has not yet been proved that a potential of 5,000 volts can be safely used. This potential, however, is now under experiment.

W. H. PREECE: I see no difficulty whatever in maintaining such a system of distributing currents by underground cables, and I form that opinion from actual experience and not from mere theory. Underground cables are safe, durable and efficient. I have had full experience of a high pressure alternating current system in Eastbourne, where such a system working with a voltage of 1,800 volts has been at work since 1886, without a single accident or failure, and is now feeding 2,600 lamps. A similar system of which I have had similar experience has been applied in London at the West Brompton Central Station; 1,800 volts have been distributed for over twelve months through 16 miles of underground wire for lighting purposes throughout the rich and flourishing neighbourhood of Kensington without a single failure.

I have been a persistent and consistent advocate of the high tension system of distributing electrical energy for many years. In a discussion which took place at the Society of Telegraph Engineers and Electricians, on April 24th, 1884, I said:—

"I do not think it is practicable or possible with the figures before us, to light up large areas on any such plan as that which has been conceived (a low tension system). It has been departed from in America, it has been departed from in suggestions here, and the day has come when, if electric currents are to be distributed for economical purposes, for lighting or other purposes, they are not to be distributed by enormous conductors swallowing up capital and ruining everybody, but they are to be smaller conductors in which high tension currents can be utilised and distributed. It may be by secondary batteries, when secondary batteries are made practical. In may be by secondary generators such as we have seen attempted on the Metropolitan Railway, though I do not know that that method has reached its practical stage yet. However, I feel quite satisfied with this, that my figures show that the distribution of electricity for lighting purposes by thick conductors by the parallel system, by such a system as that which has been proposed is, I am afraid, out of the question, because it is financially impracticable."

I have during the six years that have passed since these words were uttered, neither seen nor heard anything to change my views. On the other hand, everything has tended to confirm them. A movement that looks very like an organised conspiracy to decry electric lighting has been operating through the press of this country to impress upon this high pressure system the stigma that it is highly dangerous to person. Accidents, the result of hurried construction, careless suspension, personal stupidity, and the absence of proper regulations in New York and other cities in the States, have been so magnified that much fear and diffidence in this system have been established. But in England, where the work done is more substantial, where bare wires suspended on poles along our streets are not allowed; where supervision is organised, and where regulations are extant, there have been, during the past five years, only two fatal accidents; and it is by no means evident that even these were due to the high tension system. (I attach a schedule of the accidents that have occurred in all Europe since 1880). In London, out of 2,338 fires last year, two only were attributed to the electric wire, while gas is credited with 209.

E. FESQUET: Direct and alternating currents of high tension for lighting and power can safely and successfully be distributed by means of underground cables, provided ordinary precautions known to all electricians are taken. In my own experience I have used 3,000 volts. An installation I put up at Tours, in France, has a primary alternating current of 2,500 volts, and has been running satisfactorily during four years without accident of any kind. The conductors in this case are underground.

Q. 2. If your answer to question 1 is in the affirmative, state whether your opinion is based upon theory or upon knowledge of what has actually been done. If the latter, give a full statement of the facts upon which you base your opinion, showing, as far as possible, the extent to which high tension currents, both direct and alternating, have been distributed by means of underground cables in the various cities of the United Kingdom and the Continent; the length of time during which cables now in successful operation have been in use; the voltage of currents thus distributed in various cities, and the approximate number of lights operated in various cities by means of such cables.

Sir WILLIAM THOMSON: My opinion is primarily based on general knowledge of the insulating power of the materials used for insulating the conductors of submarine cables and electric light systems, and on measurements made in my own laboratory of voltage required to break down insulations of different kinds. A very small thickness of insulation suffices to resist 2,500 volts, and practically moderate thicknesses are not broken down with 5,000 or 6,000 volts, and are very safe with 2,500, whether direct or alternating. There has not hitherto, so far as I know, been very much practical experience of 2,500 volts on underground conductors in electric lighting, but I have great confidence that it can be carried out, whether with direct or alternating currents, successfully and with every promise of durability of the materials.

Prof. GEORGE FORBES: The opinion expressed above is founded upon experience and knowledge of what has been done, and after paying most special attention to this part of the subject for many years, and after having inspected within the last 14 months the most important electric light works in Great Britain, the continent of Europe and America.

In London, the London Electric Supply Corporation has had several miles of underground cable working at 2,400 volts (alternating) for several years. These cables are of best quality vulcanised India-rubber, laid in cast iron pipes.

The Eastbourne Electric Lighting Company began work eight or nine years ago with 2,000 volts continuous current supplied by underground conductors. At Hastings the same action was taken at the same time by an allied company. Three years ago the continuous current at Eastbourne was abandoned, and an alternating current of 2,000 volts was substituted, new underground mains being used. During all this time the condition of the cables has been perfectly satisfactory. In each of these towns the circuits cover some eight to ten miles, and there has been no case of fire, nor any loss of life.

Another allied company is the House-to-House Company in London, which has a very fine central station, working alternating currents at 2,000 volts, and has several miles of mains. These cables are generally copper covered with jute fibre impregnated with bituminous compound, and covered with lead. They are laid in cast iron pipes, with frequent manholes.

At Rome, in January, 1889, there were 17 kilometres of underground mains distributing alternating currents at 2,000 volts. These were stranded concentric cables, insulated with impregnated jute, encased in lead, served with protective compound, armour-clad with iron strips, and further protected by an outer serving of tarred hemp. These have been at work for over two years, and at the date mentioned (January, 1889) were supplying 9,000 incandescent lamps of 16 C.P., and 200 arc lamps.

At Milan, in January, 1889, there were some miles of similar cable distributing alternating currents at 2,000 volts, supplying about 1,600 lights of 16 C.P.

At Nancy (France) there were 10,000 lights in April, 1889. These are supplied by alternating currents at 2,400 volts, by means of underground mains, to which connections are made every few yards. The mains consist of stranded concentric cores, insulated and protected by iron wire strand.

At Tours (France), three years ago, the mains for working a 2,000 volt alternating system were replaced by cables insulated with vulcanised India-rubber, to the extent of six or seven miles, which have worked satisfactorily.

High pressure continuous currents have been worked through underground cables at the Silvertown Electric Works for about eight years without any trouble. The insulation is high-class vulcanised India-rubber.

Numerous other cases might be quoted. I mention those which have come under my special observation. In all of these cases the cables have worked satisfactorily. There has been absolute safety, hardly ever any irregularity in the supply, and remarkable freedom from fires.

Dr. JOHN HOPKINSON: In this country three companies are using the alternating high tension current for lighting purposes on a considerable scale, the Grosvenor Gallery Company, the Metropolitan Electric Supply Company, and the House-to-House

Company. At the present time the major portion of the conductors of the Grosvenor Gallery Company are overhead. The cables are manufactured by the Silvertown Company, and are insulated with India-rubber, and carried on separate bearing wires. From the Grosvenor Gallery station this company work at a potential of 2,400 volts. They have been at work since about 1886. So far as I know, only one death has occurred in connection with this system, and that some time ago. In this case a youth appears to have received a shock from the conductor, and to have fallen through a skylight and been killed by the fall; whether he would have been killed or not by his contact with the conductor is unknown. I understand that the Grosvenor Gallery Company have for two years had a pair of Silvertown cables insulated in the same way in a pipe under St. James's Park, and that this cable has not given the slightest trouble of any kind. The Grosvenor Gallery Company, or rather their successors, the London Electric Supply Company, are establishing a station at Deptford, for supplying parts of London. From this station it is proposed to supply at a tension of 10,000 volts; but, so far as I am aware, satisfactory working has not yet been attained with so much as 5,000 volts.

The Metropolitan Electric Light Company have at present two stations on the alternating system, both working at 1,000 volts. From Sardinia Street at the present time they are supplying about 500 H.P.; from Rathbone Place, about 100 H.P. The cables are almost all laid underground. They are Silvertown India-rubber insulated cables laid in iron pipes, several cables in each pipe. With these cables they have had no trouble of any kind, either in the way of breaking down of insulation or of shocks. The experience of this company appears to show that it is desirable that the iron pipe should be cast in a vertical position, by so doing chaplets may be dispensed with, which, if present, tend to leave points within the pipes liable to injure the cable.

A Silvertown cable in an iron pipe has been in existence under a potential of 2,400 volts underground in St. James's Park for about two years.

The House to House Company have one station at work in London, from which they have about 16 miles of cables. These cables are also manufactured by the Silvertown company, and are laid in iron pipes, in the same manner as are the Metropolitan Company's cables. The House to House Company work at a tension of 2,000 volts. They have at present about 6,000 8-C.P. lamps connected up, and 11,000 wired. I understand that their maximum output is about 55 ampères, or 110 kilowatts. The House to House Company have also stations at Eastbourne and Brighton, but their London station is probably the best of the three.

Concerning recent Continental practice, I am not prepared to answer from my own knowledge.

W. H. PREECE: The currents for the alternating current high pressure system in England are safely and successfully distributed both by means of continuously well insulated and properly suspended overhead cables, and by means of thoroughly well insulated conductors buried underground in pipes. The voltage used is generally from 1,800 to 2,400 volts.

E. FESQUET: My opinion is based on practical experience extending over ten years, during which I have been entirely employed in alternating current work. Since 1885 a central station in London has been distributing light by means of alternating currents of 2,400 volts and transformers, by means of conductors which are partly overhead and partly underground, the number of lamps supplied being about 20,000. Other companies have since been working in London and provincial towns, with alternating currents of 2,000 to 2,500 volts. One alternating current plant has a tension of only 1,000 volts.

I put up a station in Germany in 1885, when the alternating current used was 2,500 volts—the conductors were overhead—the number of lamps being about 2,500. This station has worked up to the present time with perfect success and without accident.

I also put up a station in Italy in 1885, when the alternating current used was 2,500 volts—the conductors being overhead—the number of lamps about 500. The working has been regular, successful, and without accident.

Q. 3. Give some idea of the character of the cables used and the manner in which they are laid?

Sir WILLIAM THOMSON: A great variety of plans may be used safely and successfully for both direct and alternating currents. One method of alternating currents consists in placing the two conductors as coaxial cylinders, having sufficiently thick space between them filled with insulating material; surrounding the outer conductor with a less thick layer of insulating material, and enclosing the whole in a lead or iron pipe. The conductors for this system may be copper tubes, but it is generally preferable to make them of wire strands laid with a moderate twist on the proper cylindric surfaces. The inner conductor should be of six strands laid spirally as close together as possible, on a hempen or other non-metallic core. Each wire should be prevented from metallic contact with its neighbours by slight insulation. This method gives practically absolute security against danger to the public.

Prof. GEORGE FORBES: The types of cable which have done such good service for high pressure work, are generally known in the trade by the following names:—

(1) The Silvertown vulcanised India-rubber cables.

(2) The Siemens concentric cables.

A year ago I had occasion to draw attention to serious breakdowns in the lead-covered type of cable in the electric lighting system of Berlin. This system is worked at low pressure, and very large conductors must be used. The outside of the cable is some three inches in diameter, and when coiling this on a four-foot drum, I conceive it to be quite possible that the lead is severely strained, and, becoming punctured, admits water. This is not so much to be feared with the smaller cables used with high-pressure currents.

As to the manner of laying the conductors, the Siemens concentric cables being ironclad, and being generally laid under the footway, do not require any further protection. In crossing streets they are generally run in pipes.

The vulcanised India-rubber cables are laid in wooden boxes, concrete troughs, or iron pipes. The last of these plans is the most generally adopted. Vulcanised rubber can only be used when of the best material. It then cannot be excelled. Its quality for durability may be judged by tests of its insulation resistance.

The lead covered cables are now generally drawn into iron pipes.

The weak part of the cable is at the junctions to the service lines. Special care must be paid to the manner of insulating these joints.

Dr. JOHN HOPKINSON: I have already indicated the character of the cables used.

W. H. PREECE: My view is that there is nothing more practical than 4-inch or 6-inch cast iron pipes, laid from one to three feet underground in which thoroughly well insulated and well protected copper conductors are drawn. There are several insulating materials in the market capable of insulating 2,000 volts, but my experience is chiefly with India-rubber. I see no difficulty whatever in maintaining a pressure of 2,000 volts in underground conduits. It has already been done for eight years in Eastbourne.

N.B.—For 4½ years, 2,000 volts continuous current (Brush) were used.

E. FESQUET: The conducting cables used in England, France, Germany and Italy, by me, have been India-rubber covered cables, not concentric—the latter being laid parallel to prevent induction. When cables are laid underground, I use a cast iron pipe or wooden trough filled with bitumen, the cable being supported by bridges.

Q. 4. What is your opinion as to the safety to the consumer and the public at large, of the converter or transformer system of electric lighting, involving the use of high tension alternating currents in the street mains?

Sir WILLIAM THOMSON: With properly laid mains the high tension alternating currents in the street mains underground, involve, I believe, no danger whatever, to the public at large. The converter or transformer system can, I believe, be made absolutely safe to the consumers by proper arrangements. It has already been largely practised in London, Glasgow and elsewhere; and as far as I know, no instance has occurred of any consumer having met with an accident.

Prof. GEORGE FORBES: Previous to 1885, when a low pressure system alone was available, engineers were in search of some high pressure system which would reduce the copper required to a reasonable amount. Their attempts were mainly in the direction of a parallel series system. But they could not recommend it, because of the danger from defective insulation in the house wiring causing high pressure shocks to the consumers. After the alternating current transformer system had been proved to be efficient, it was accepted as the required solution of the difficulty, because the house wiring is, on this system, completely separated from the street mains. Every one in this country who then came to this conclusion, and has had experience of the system, has been confirmed in his belief that the transformer secured the required safety.

Dr. J. HOPKINSON: There is in my opinion no reason whatever why high tension alternating currents should not be used in the street mains.

W. H. PREECE: I have advised the Metropolitan Electric Supply Company, of London, to adopt the same system, and they are doing so, and I have also advised several local authorities in England to do the same thing, and they are going to do it.

I do not express my opinion lightly on this subject. There are about 30,000 miles of underground insulated wire of the United Kingdom under my control, and I have had 37 years' experience of such wires. I venture to think that this experience is unique in its continuity and extent.

E. FESQUET: The converter or transformer system involving the use of high tension alternating currents, can be used with absolute safety to the consumer and the public at large. No accident can happen if well-known precautions are taken, and the neglect of them implies great ignorance.

Q. 5. What is your opinion as to the relative fire danger in the transformer or converter system and in the low tension direct current system, respectively?

Sir WILLIAM THOMSON: In the event of the escape of gas, in the neighbourhood of the high tension mains, the high tension alternating current may set it on fire; but probably not so the low tension direct current. Within a house or building in which the electric light is used, the danger of fire is not materially different in the two cases, and in either it may be practically annulled by proper arrangements. I believe, also, that the transformer itself, when properly constructed, and properly mounted and guarded, does not cause any danger of fire.

Prof. GEORGE FORBES: In a low pressure net-work system

of mains, the resistance is very low, so that if a short circuit occurs in any house wiring (or, if the mains leak, a connection of the house wiring to earth suffices), it is quite possible to have 10,000 ampères, or more, going through these house wires, previous to the going of the fuse, even if the fuse is in good working order. This current, even if it lasts only a small fraction of a second, is able to cause fire-risks. With the transformer system this is not at all the case. The possible current is here limited by the size of the transformer; in the direct supply system it is limited only by the possible output of the central station. The transformer system is safer, because the house wiring is detached from street mains. If the street mains have a bad leak, a contact of the house wiring with gas or water pipes may cause a fire on the direct system, but not so on the transformer system. With proper precautions, however, strictly enforced, as in England, to prevent a short circuiting of the house wiring, and to prevent leakage from the street mains to earth, both systems are absolutely safe.

Dr. JOHN HOPKINSON: In my opinion there is practically no difference as regards fire risks between the converter system and the direct current system.

W. H. PREECE: There is no more danger of fire from the one system than there is from the other. Perhaps the low tension direct system is the more dangerous of the two, for its fancied security leads to relaxed supervision, while there certainly are conditions when an intense low tension current is more dangerous than a 2,000-volt alternate current. It is an anomaly, though a truism, to say that where there is most danger there is the greater safety; and the reverse is equally true. The reason is that where there is danger there are precautions taken; where there is supposed safety, supervision and care cease.

The immunity from accidents on our British railway system, and on our great steam shipping lines is an illustration of what results from careful inspection and proper regulations. A first-class railway compartment on the Midland Railway, or a state saloon on an Atlantic liner, is as safe a position to be placed in as in a drawing-room arm-chair. The system of boiler insurance and supervision in this country has an equally striking and satisfactory result. Boiler explosions are very few and far between.

E. FESQUET: The fire danger in a properly arranged transformer or converter system, may be made much less than in the low tension direct current system, the large quantity necessarily carried by the latter being always a source of danger; besides, its main system must always be directly connected with the house service, and no amount of protection fuses can alter the fact.

In a direct current system distributing mains and house circuits being connected, it is difficult to detect the exact spot where a leak may have occurred, but in the transformer system, a leak in the conductors inside the houses of consumers, can never be connected with the distributing main, and the position of a leak in this latter is easily detected.

Q. 6. In your opinion, is the converter or transformer an effectual safeguard to protect the user of electric illumination from danger from shock or fire?

Sir WILLIAM THOMSON: In my opinion, the transformer, when properly made, properly mounted and supplied with proper safeguards, is thoroughly effective to protect the user of electric illumination from danger from shock or fire.

Prof. GEORGE FORBES: If the transformer has its primary and secondary coils made separately and insulated separately, and if fuses are placed in both primary and secondary circuits, and if the mechanical construction is such that there is no rubbing and wearing of the insulation between primary and secondary coils, then the transformer is an absolute protection to the consumer against fire and life risks. All these requirements can easily be fulfilled. Major Cardew's safety device suffices to render even bad transformers a protection to the consumer.

Dr. JOHN HOPKINSON: In my opinion, a properly constructed converter with a suitable cut-out is an effectual safeguard to the consumer against danger from shock. As regards fire, the precautions must be the same as with the direct current system.

W. H. PREECE: The safety of a high pressure system is entirely a question of precaution, design, and care. If the following rule be carried out:—

"Alternate current transformers must be supplied with two main fuses, double-pole switch, and an *earthing device* on the secondary circuit, all of which must be securely fixed in a water and fire-proof structure (by preference situated outside the premises) placed under lock and key, and beyond the control of any unauthorised person"—

and the work in a house be thoroughly well done and maintained, I can conceive of no danger to person or to building which can arise. The earthing device is a most efficient and satisfactory safety valve. But if maintenance be neglected, if the cheap Jack and the Jerry builder be admitted, if safety devices are neglected, then the electric system can become as dangerous as gas, and the converter might emulate in insecurity the kitchen boiler or the steam pipe.

E. FESQUET: Yes. Under proper conditions.

Q. 7. State to what extent the converter or transformer system is now being used in London and other cities in Europe for lighting from central stations, as compared with the low tension direct current system, and in favour of which of the two systems the present development in electric lighting in Europe seems to be?

Sir WILLIAM THOMSON: The present development of electric lighting in Europe seems to be in favour of the transformer system on the whole, because of the facilities it gives for transmitting the electric energy over great distances with moderate amounts of copper.

Prof. GEORGE FORBES: The best idea that can be obtained as to the relative use of low pressure direct supply, and high pressure alternating current transformer supply, at the present time, is to be got by analysing the evidence given before Major Marindin, at the Board of Trade enquiry on the electric lighting of London, in 1889. The following table shows the companies which were given powers for one or other of these two systems, the capital which had been authorised, the amount which had been paid up at the date of the inquiry, and the number of square miles in London allotted to them:—

LOW PRESSURE DIRECT SUPPLY.

	Authorised capital.	Paid-up capital.	Area, square miles.
Westminster Electric Supply Corporation	£100,000	£8,000	1·5
Kensington and Knightsbridge Electric Lighting Company	250,000	37,240	1·1
St. James and Pall Mall Electric Light Company ...	100,000	26,000	0·3
Total	£450,000	£71,240	2·9

HIGH PRESSURE TRANSFORMER SUPPLY.

	Authorised capital.	Paid-up capital.	Area, square miles.
London Electric Supply Corporation	£1,250,000	£585,000	5·3
Metropolitan Electric Supply Company	500,000	152,732	3·7
House-to-House Electric Light Supply Company ...	350,000	41,600	1·1
Total	£2,100,000	£779,332	10·1

The most certain way of judging of the comparative amount of business being done by the several companies is, to compare the paid-up capital in each case. Here we find that the companies working on the low pressure direct supply system had contributed 8·4 per cent. of the total paid up capital, while those using the high pressure alternating system had contributed 91·6 per cent. of the total paid-up capital. I should mention the fact that a small area was allotted to a company called the Electricity Supply Corporation, but I can find no evidence in the reports as to what system they are to adopt, nor any facts about their capital. The Notting Hill company, so far as I can learn, is not doing anything. The Chelsea company is a high pressure supply, reduced in pressure by batteries.

The general evidence elsewhere in England and Europe generally is, that at present high pressure is most generally adopted, and almost always on the alternating current system. A very significant fact is that Mr. Crompton, who was a most able advocate of the low pressure system, has lately secured the contract for lighting the town of Chelmsford, and has himself selected the alternating high pressure system with transformers. It is my firm conviction that at present and until a storage battery is found which is cheap, efficient, and durable, most of our municipal lighting in Europe, including Great Britain, will be on the alternate current high pressure transformer system, and that only in exceptional cases can a low pressure supply be economically given.

Dr. J. HOPKINSON: In addition to the alternating current system stations there are in this country certain direct current installations. In London there are the St. James's Company, the Chelsea Company, and the Kensington Court Company. In the provinces there is Bradford, and there are other places. So far as I am able to judge, there seems to be a somewhat larger application of the alternating current than of the direct in London. Taking the whole of the country, it is difficult to say; it is proposed to apply each in many places.

W. H. PREECE: The system of distribution in houses is essentially a low pressure system, whether the energy be derived from alternate current converters, continuous current batteries, or low tension central stations. The high pressure and supposititious danger are confined to the external mains and feeders, which, if kept underground, can be made absolutely safe.

E. FESQUET: The present development in Europe, including London, is greatly in favour of the alternating system.

Q. 8. Explain to what extent high tension currents, direct and alternating, are necessary for the successful and economical distribution of electricity for lighting and power purposes, and state what, in your opinion, would be the effect upon the electric light and power industry, and the interest to the public in general, in case the use of

high tension direct and alternating currents were abandoned, and all lighting and power work done exclusively by means of the low tension direct current system?

Sir WILLIAM THOMSON: The mass of copper required for the economical transmission of electric power to distances of more than a mile is so great, relatively, to the value of the work done, if the potential be limited to 100 or 200 volts, that, in my opinion, it would be fatal to the electric light and power industry, and to the interests of the public in general, to abandon the use of much higher potentials than 200 volts.

Prof. GEORGE FORBES: The reason why electric lighting from central stations made no progress in England till 1885, was only in part due to the Electric Lighting Act. It was mainly due to the fact that electricians saw that the copper required for feeders from a central station to supply 100,000 lamps on the three-wire low tension system, on the most economical principles, must have a total section of at least 50 square inches each, which is impractical. They resolved to wait until a satisfactory high tension system should be worked out. Of these, the parallel-series system could not be adopted, because the house wiring was in direct connection with high pressure mains. The storage battery system might have been used, if the efficiency, economy and durability of these were sufficient for practical work on a large scale. Even now, the secondary battery has not been sufficiently perfected in these directions. If it were it would be very generally adopted. The transformer system is the only one which has satisfied those engineers here who have had experience, as an economical and safe means of converting high into low pressure. For large towns high pressure is a necessity, especially in America, where the houses which are to be supplied are often at great distances from each other. If high pressure systems were abolished in England electric lighting would, from an engineering point of view, be in the same position as five years ago. Central stations could then be started only in extremely concentrated districts where light is used up to late hours.

Dr. J. HOPKINSON: The great advantage of the high tension system is that the generating station may be placed at a considerable distance from the work to be done. In cases where the generating machinery can be put close to the work no doubt the direct system would be adopted. But in large towns this is not unfrequently impossible, not alone upon the ground of capital outlay in real estate, but also on the ground that the powerful machinery required would be an annoyance in the neighbourhood. Thus, if high tension currents were prohibited it would involve two things for the public, a much greater cost of supply and the annoyance of machinery placed in a place where it is undesirable.

E. FESQUET: The high tension systems, both with direct and alternating currents, are essential to an economical distribution of light and power—the possibility of using water power at a distance is itself an element in the question which is an obvious advantage; even if steam power is used, it can be done more economically outside a town; then the possibility of concentrating at one point the motive power required for supplying a large district with light is an immense advantage from an economical point of view; it is probably the possibility of establishing central stations to supply large areas from which may be considered to start the general application of electricity. If all lighting and power work were done exclusively by means of low tension direct current, the advantages within the reach of all would be withheld until a wiser generation should arise to take advantage of the facilities offered by the high tension system. By every direct system the consumer can use only one kind of lamp; by means of converters the consumer can select any type of lamp.

Q. 9. Can high tension, direct and alternating currents be safely distributed by means of overhead conductors? If so, under what circumstances, and by means of what precautions?

Sir WILLIAM THOMSON: Yes, I believe perfectly and easily, except in cities; and even in cities by the observance of the rules for public safety which have been imposed by the British Board of Trade. For the transmission to great distances over the country I believe electric energy can be conveyed by currents, whether direct or alternating, through a pair of bare copper wires, at a distance of from five inches to a foot from one another, insulated by porcelain or glass insulators, and supported on poles, with perfect safety to the public. The requisite security against the possibility of electric damage to man or beast through breakage of a wire or blowing down of poles can, I believe, be made practically perfect by proper appliances.

Dr. JOHN HOPKINSON: The experience of the Grosvenor Gallery Company shows that high tension alternating currents can be safely distributed by means of overhead conductors; this has been attained by the use of thoroughly well insulated conductors carried upon independent bearing wires.

Prof. GEORGE FORBES: High pressure direct or alternate currents can be safely distributed by means of overhead conductors, if proper rules are made, and means arranged for enforcing them. In the last five years the central station at the Grosvenor Gallery in London has supplied by overhead conductors alternating current at 2,400 volts to about 15,000 16-candle power lamps, or the equivalent. The contractors foresaw that carelessness on their part might lead to accidents, and so to condemnation of their works. The work was all of the best. Best vulcanised India-rubber insulation braided, was used, and the mechanical construction of the lines was excellent. The cables are all supported by insulating suspenders on a steel wire. The supports are all firmly stayed on the tops of houses. Inspection of these is perfectly easy. There has never been a death from shock, except perhaps one, where, however, the sufferer fell from a house roof, and the cause of death was uncertain. Fires on this system have been almost unknown. The rules for overhead wires, prepared by the Board of Trade, are in my opinion more than sufficient for the protection of the public. Æsthetic considerations prevent us at present from suspending our cables on poles in the streets. In towns where elevated railroads are allowed in the streets, I do not think that this consideration need have much weight.

E. FESQUET: I have put up several overhead conductors for alternating currents at high tension. The poles I have used have been generally iron, the insulators of porcelain, the India-rubber covered conducting cable has been sometimes supported by a steel wire. Storms that have wrecked telegraph and telephone wires have left my conductors uninjured, and I have never had any accident from the current during my experience of 10 years.

Q. 10. Kindly make any other suggestions which occur to you which will bear upon the present discussion in the United States as to the conditions under which electric lighting from central stations can be most safely, successfully and economically done?

Sir WILLIAM THOMSON: The comparatively small currents required in the mains on the high tension alternate current system give it many advantages over all low tension systems; as, for instance, the smallness of the conductors and consequent ease of laying as well as economy of prime cost; and the security against any current strong enough to do damage underground or elsewhere being allowed at any time to pass through them, through any accidental short-circuiting at crossings.

Prof. GEORGE FORBES: I have been in the United States this year, and seen the condition in which New York City is at present. This would all have been prevented if the electric lighting companies had looked to permanent rather than temporary profits; if the Board of Electrical Control had been composed of able and unbiased electric engineers; or if the civic authorities had not lost their heads. It has been a foolish thing to insist on putting the wires all underground, if the public have a right to expect the most for their money. The cost of electric light will be thus increased fully 50 per cent. What ought to be done is to register every electric light wire, and subject it to strict regulations, such as those issued by the English Board of Trade, under the advice of the Institution of Electrical Engineers. Of course it is only high pressure mains which could be carried overhead for light and power purposes. Low pressure ones would be too large. If panic legislation were to stop the use of high pressure currents of electricity the public would be largely deprived of a great boon. I must qualify my remarks by saying that in Broadway and many other business parts of New York, where large numbers of telephone wires must of necessity be allowed to occupy the air space, it may be necessary to compel electric light wires to be put underground.

To prevent my remarks in Answer 3 from being the cause of mistakes, I wish to state that in using vulcanised rubber cables the joints must be vulcanised by experienced men.

Dr. J. HOPKINSON: In my own practice I am guided in the choice of high or low tension entirely by the consideration of where the generating plant is to be placed. If it can be conveniently placed in the immediate neighbourhood of the whole of the work to be done, I adopt the direct system of supply at low tension; if this is not the case, however, I advise the adoption of high tension alternating currents.

W. H. PREECE: It is an absurdity to argue that because alternate currents of high pressure will cause death that therefore electric lighting by alternate currents is dangerous. You might as well argue that it is dangerous to eat food with a knife because a man cut his throat in a fit of jealously; or that it is dangerous to light a fire because a child burnt its finger by picking up a live coal. Danger depends much more upon the personal element than on that of principle. Accidents in all spheres are generally due to carelessness, reckles-ness, or ignorance. More people are killed by blowing out gas than by electric currents, and there are more people killed by the traffic in the streets of London every week than in the whole of the United States by electricity every year.

Safety (certainly with electricity) is easily purchased by exact design, efficient material, experienced workmanship, proper supervision, and careful maintenance, and this can be acquired by high tension alternate currents as readily and as well as by any other form of electrical energy.

E. FESQUET: I consider that substantial, safe, and reliable work can be done at price; which will enable a good profit.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

"On Signalling across Rivers in India," by W. F. MELHUISH, member. (Paper read April 10th, 1890.)

Rivers which intercept lines of telegraph are crossed either by means of ordinary wires supported on masts of wood or iron, or by means of cables; and experience has not only shown that the former method is preferable, but also that the life of a river cable in India is a very precarious one. However, in the case of rivers

of greater breadth than can be spanned, cables must be employed. The causes which affect river cables will be only briefly noted here; they are :—

1. Deterioration of the shore ends by changes of temperature affecting the dielectric.
2. Damage from anchors of ships and steamers.
3. Alteration of the channels and cutting away of the banks.
4. Damage to the dielectric by lightning.
5. Imperfectly made joints.
6. Attacks by white ants and rats.

It not unfrequently happens that a river cable fails entirely, or becomes imperfect at a time when, owing to the force of the stream, a new cable cannot be immediately laid, or when there is no ready-made cable available, or when a considerable period must elapse before the new cable can reach the river. To provide for these contingencies attempts have from time to time been made in India to signal across rivers without cables, and it may be of general interest to know what has been done in this respect by myself and others.

Three different methods appear to have been discussed and attempted, viz. :—

1. Signalling through an imperfectly insulated wire.
2. Signalling through an ordinary bare wire.
3. Signalling without any metallic conductor.

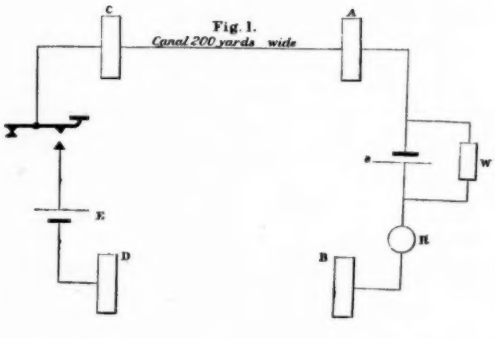
More than 30 years ago, Mr. Van Rees, between Portsmouth and Gosport, in salt water, and subsequently Dr. Gintl in fresh water, tried to signal without a wire; but the result was in both cases a failure, and was supposed to be so because the resistance through the earth between the two groups of earth-plates on the same side of the river was too small as compared with the resistance between the two groups across the river. For success it was assumed to be necessary to bury the two groups of earth plates on each bank from a quarter to a half mile apart, and to connect them by thick insulated wire.

In India, about the year 1858, Mr. Blissett acted on this plan, and obtained a fair measure of success by employing land-lines of considerable length on either bank of the river.

In the year 1876 the late Mr. Schwendler made some experiments across the river Hooghly at Barrackpore, near Calcutta; and subsequently, during September, 1879, the late Mr. W. P. Johnston, electrician, made the following experiments :—

On the 9th September, 1879, he attempted to signal across a broad canal *without* any metallic conductor. Fig. 1 is a diagram of the connections, &c.

Fig. 1.
Canal 200 yards wide



E = 10 Bunsen's cells joined in series;
R, a needle instrument having a resistance of 1 ohm, also a bell telephone having a resistance of 4·25 ohms;
W = a resistance of 1 ohm
e = four Minotto cells joined parallel.
} This arrangement exactly balanced the natural current through the receiving instrument.

A, B, C, D were copper plates, 8 feet 8 inches by 4 feet 4 inches by $\frac{1}{16}$th inch thick, buried on the banks of the canal. B was buried 15 yards distant from A, and D was buried the same distance from C. All the plates were buried parallel to the canal. The resistance between A and B was 7·5 ohms, and that between C and D was the same.

Under these conditions both the needle instrument and the telephone (used, of course, as a telegraph, and not as a speaking instrument) gave distinct and readable signals.

After several days of experiment with the second method, using a single bare 600 lbs. per mile galvanised iron wire, the following results were obtained :—

E = 15 Bunsen's cells in series;
R, a polarised Siemens relay of 21 ohms resistance;
e = 4 Minottos joined parallel
W = 10 ohms
} Balanced the natural current.

The measured resistance of the circuit was + 2 — 20 ohms. The signals received were quite regular and safe; the tongue of a relay worked an ordinary sounder in local circuit, and no difficulty was experienced in balancing the natural current through the relay. To balance this natural current is a most important element of success in this mode of telegraphing.

Subsequently three miles of the same wire were laid along the canal, the wire having previously been passed through a mixture of pitch and tar, and for the hour the instruments were in circuit perfect signals were received.

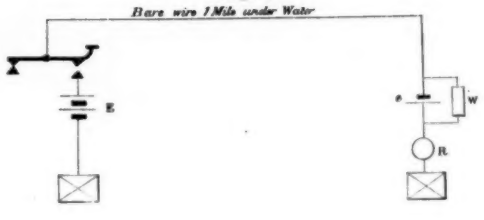
The experiment with the bare wire for a distance of one and a half miles was not successful; and as it appeared that in order to obtain signals the battery power would have to be increased as the square of the distance, the limit through which signals can be received on bare wire under water is very soon reached.

During May, June and July of the year 1888, Mr. Johnston made a long series of trials across the canal and the river Hooghly, and the subsequent measurements and experiments led him to come to the following conclusions, viz. :—

That up to 1½ miles it is perfectly easy and practicable to signal through a bare wire under water.

That for greater distances, judging from experiments, it is not possible to signal in this manner.

Fig. 2.
Bare wire 1 Mile under Water



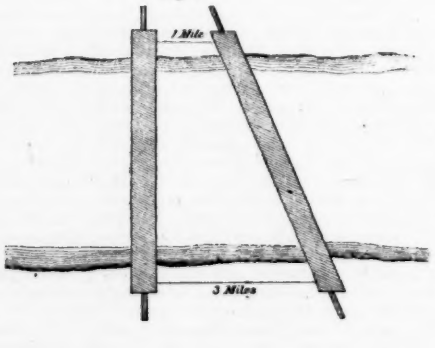
In April, 1889, Mr. W. P. Johnston died, and the duties of electrician were entrusted to me. Having studied the recorded labours of my predecessor, and learnt that by pursuing the same lines it was hopeless to expect to be able to signal through a bare wire across a river that had a greater breadth than one and a half miles, I resolved to change the class of signalling apparatus and to continue the experiment. Discarding continuous steady currents and polarised receiving relays, I adopted Cardew's vibrating sounder, and the sequel will show how completely successful the change of instruments proved to be. I began from the beginning, and tried to signal across a water-way without a metallic conductor by laying down two earth-plates on each of its opposite banks. Readable signals having been exchanged, the distance separating each pair of plates was varied with the view of ascertaining how close the plates might be brought together, the signals remaining still readable. Readable signals were exchanged when the distance separating the plates was equal to the breadth of the river, reading becoming more difficult as the plates were made to approach each other, and clearer and more distinct as the distance between the plates was made to exceed the breadth of the river. I learnt from these experiments that in order to obtain signals of sufficient distinctness for the practical purpose of transmitting messages, it would be necessary to construct a line on each bank of a river much longer than the breadth of the river; and as the rivers along the coasts in India are extremely wide, I became impressed with the impracticable character of such an undertaking, and decided to strike out a new line. This new line was the laying of two bare uninsulated iron wires across the water-way parallel to each other, and separated by a certain distance, the ends on each bank being looped together by means of an insulated conductor. Hence, though much of the circuit was laid under water, it was nevertheless a continuous metallic circuit. Beginning first with a complete square by laying the wires as many yards apart as the river was wide, signals were instantly exchanged that were incomparably louder than those that were exchanged when the same area was bounded by four earth-plates. The length of each of the two wires under water was next gradually increased to 740 yards, and the distance separating them gradually diminished to 35 yards, the strength of the signals diminishing proportionately, and ceasing to be readable when the wires were further prolonged. The conclusion arrived at from these experiments was that for the practical and useful purpose of signalling messages across a broad river in the absence of an insulated cable, a complete metallic circuit was at least desirable. Acting on this conclusion, it was sought to apply it practically, and the following experiment was carried out :—At a distance of 15 miles west of Calcutta a cable is laid across the river Hooghly, which at this point is 900 yards wide. The iron guards of this cable were employed to form one of the metallic conductors, and at a distance of 450 yards down stream a single wire, weighing 900 lbs. per mile, was laid across the river to form the second metallic conductor, insulated land-lines having been run up to loop the two parallel conductors together. The experiment was quite a success, the signals being readable without difficulty.

An experiment was next made on a defective cable across

Channel Creek, at the mouth of the river Hooghly. This creek is crossed by two cables laid in the same trench; the length of each is 3,000 yards, and one of them had been completely parted by a steamer's anchor. Several attempts were made to signal across by using the guards of one of the cables as a lead, and the guards of the other as a return wire, but the efforts proved unsuccessful owing to the too close proximity of the cables. For every cable crossing there is a certain minimum distance apart at which the cables must be laid, and if this minimum, which depends on the breadth of the river, be exceeded, an absolute short-circuit becomes established. But although it was not possible here to signal through the iron guards, the most perfect signals were passed through the two conductors when they were formed into a loop, notwithstanding the fact that the two ends of the broken conductor were exposed in the sea and were lying at a considerable distance apart. An experiment was now made in order to ascertain what chance there might be in the future of signalling across the two conductors, should an accident occur to the good cable. Accordingly the conductor of the good cable was disconnected in the cable-house from the signalling apparatus and placed upon the ground, when the signals, though greatly diminished in volume, still continued to be distinctly readable. It may therefore be reasonably inferred that should the good cable suffer a similar fate to that of the defective cable, communication can, by means of Cardew's sounders, be kept up by looping the ruptured conductors until arrangements can be made for laying a new cable or repairing the defective ones.

It will probably suffice if from the succeeding experiments that were made to test the efficiency of the vibrating sounder in the case of conductors breaking down at river crossings, I select the following three, exhibiting as they do progressive evidence of the value of this signalling instrument, and culminating in establishing it beyond dispute as one that can be relied on for carrying on independent communication through the iron guards of cables while the insulated copper conductors form parts of other circuits.

Fig. 3.



EXPERIMENT No. 1.

The local line from the central office, Calcutta, to Garden Reach is about 4 miles in length, and at about midway the wire spans a a small river. Vibrating sounders having been put in circuit at each end of this line, the wire where it crosses the river was taken down and laid along the bed of the water-way. Signals were loud and clear at both ends.

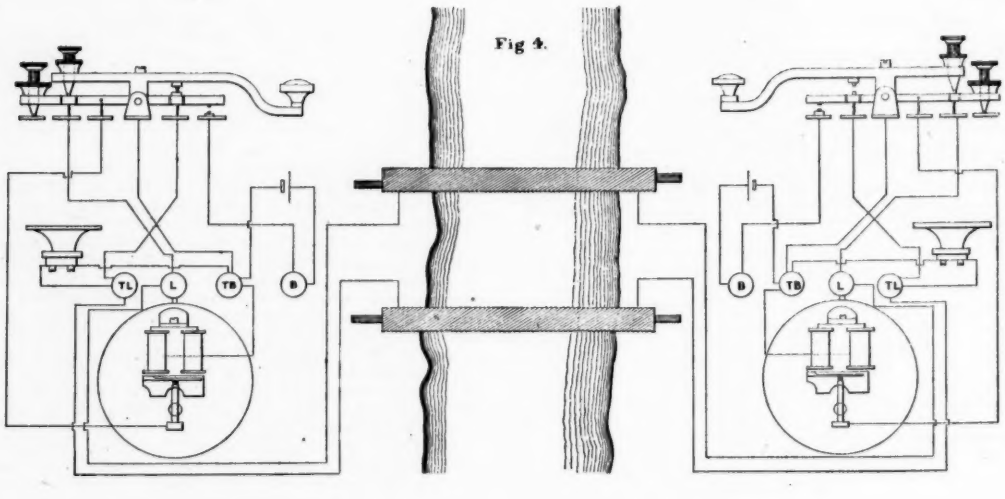
From the success of this experiment it may be inferred that on any ordinary line, should the wire from accidental causes come off the insulator and make earth by touching the bracket, standard, or ground, or should the wire break and both ends of it be lying on the ground or in a water-course, communication could still be maintained by means of the vibrating sounders.

EXPERIMENT No. 2.

The line wire which connects the town of Chandernagore with Barrackpore is about 10½ miles long, 900 yards of which consists of a cable laid across the river Hooghly. Vibrating sounders having been joined up in the telegraph offices at Barrackpore and Chandernagore, the insulated conductor of the cable was thrown out of circuit, and the line wire on each side of the river was joined to the iron guards of the cable; thus for a length of half a mile out of 10½ miles the conductor was wholly under water, yet it was found quite feasible to transmit messages between the two offices.

From the success of this experiment it may be reasonably inferred that in the case of certain cable crossings where the rivers are not too wide, should the copper conductor of the cable make dead earth or become insulated by parting, communication could still be kept up between the two offices on either side.

Fig 4.



EXPERIMENT No. 3.

The terminus of the Northern Bengal State Railway at Sara is separated from that of the Eastern Bengal State Railway at Damukdia by the river Ganges. The opposite banks of the river in this locality are connected by two independent cable crossings. The length of one of these crossings is 1 mile 610 yards, and of the other 4 miles. The distance which separates the two cable houses on the Damukdia side is 3 miles 1,584 yards, and on the Sara side the cable houses are only 1 mile 211 yards apart, giving a mean lateral distance in alignment of 2 miles 880 yards

The two cable houses on each bank of the river have an insulated connecting land line. The two cable crossings and the connecting land lines form an irregular metallic circuit somewhat resembling that given in fig. 3.

The connecting land lines having been joined to the iron guards of the cables, two vibrating sounders were placed in circuit, one on each side of the river, when signals so strong were transmitted across that it was not difficult to read them at a distance of 6 feet away from the receiving telephone.

From the marked success of this experiment it may be inferred that at all river cable crossings where the cables are laid in separate alignments (and the farther apart the better), should the cables become interrupted, communication may still be maintained from bank to bank by using vibrating sounders, thus avoiding the delay, inconvenience, and cost of a boat service.

It should also be remembered in the case of such a parallel cable crossing, that besides the circuits afforded by the copper conductors when these are in working order, there is always an additional local circuit available by means of the iron guards between the opposite cable houses, and that this circuit could be

used by means of the vibrating sounders as a talking circuit, in cases of necessity, without interrupting through working on either of the cables.

Each of these three experiments may properly be described as a delicate experiment. With so much of the conductor under water, the quantity of current which reaches the receiving telephone is so infinitesimal that signals could not be successfully transmitted if the vibrator were joined up in the ordinary manner. It is desirable in circumstances similar to these to reduce all the resistance external to the actual connecting lines to as small a quantity as possible, and therefore, when messages are being transmitted, the telephone at the sending end should be removed from the circuit, as also should the vibrator from the receiving end. To effect this two-fold purpose a special form of signalling key (designed by the writer) is requisite, and should be used. The action of this key, together with the complete set of connections for a parallel cable crossing, is shown in fig. 4.

DISCUSSION (*Authorised Abstract*).

Major CARDEW said he was glad to hear that his vibrating sounder had been so serviceable in the experiments described in the paper. He did not consider himself entitled to much credit for his sounder, as similar instruments had been used by others before him, it was rather the system he described before the Society in 1886 that was of importance. This system had been found extremely useful in cases of emergency, such as occurred when the last heavy snowstorm broke down nearly all the wires in the metropolis. The idea of obtaining communication by bare wires, as mentioned in Mr. Melhuish's paper, seemed to him good, and he thought copper wires would be better than iron ones. In addition to the armour of cables being used as a local talking circuit, it was easy, he said, by using the vibrator, telephone and small condensers, to talk along the main conductor without interfering with the through traffic. Referring to the special signalling key shown in fig. 4, he said that in his 1886 paper he had given an arrangement for producing the same effect, in what he considered a more practical way.

General WEBBER considered the questions dealt with in the paper of considerable importance in practical telegraphy. The life of river cables in India was, he said, very uncertain, due in some measure to the great variations of depth which the rivers undergo; in some cases the depth changes from 5 to 60 feet in a single season. It must not be supposed, however, that cables could not be used successfully in rivers, for during the Franco-German war a six-wire cable was laid from Bromley to London, along the bed of a small stream, in order to complete the communication with France *via* Beachy Head. This worked satisfactorily for six months. Another instance occurred at Wady Halfa in the Soudan, where a piece of ordinary field line was laid across the Nile and served to transmit messages until an armoured cable was obtained. This latter cable was very successful. Referring to the use of Cardew's sounders for signalling without wires, he said the idea was not new for they were employed some years ago in signalling across the Solent between Hurst Castle and Yarmouth. It was also found possible to communicate between Portsmouth and Newport, a distance of about 35 miles *via* Hurst Castle and Yarmouth, although no metallic circuit existed between the two latter places, which are six or seven miles apart. The vibrator and telephone were also found very useful in Egypt for signalling through a badly insulated wire to a linesman who had gone to search for the fault.

Mr. CHAS. BRIGHT said the utility and importance of Mr. Melhuish's experiments were not confined to communicating across rivers, but had a direct bearing on the difficulties existing in signalling between lightships and the shore. Mr. Willoughby Smith, he understood, had been successful in signalling to boats without communicating wires, but Mr. Melhuish seemed to have failed in similar experiments. He was not aware whether Mr. Smith's experiments had been proceeded with.

Mr. GRANVILLE, referring to the method of signalling across rivers by uninsulated cables and insulated land lines, said he had recently found a patent, dated 1858, in which the method was described, and he believed it was tried between England and Ireland, but without success. Mr. Willoughby Smith's experiments were quite satisfactory, and they had been discontinued partly because the Telegraph Construction and Maintenance Company had overcome the difficulties in signalling to lightships in another way, and partly owing to Mr. Smith's ill-health.

Mr. WYLES was not surprised at the success which had attended Mr. Melhuish's experiments with Cardew's vibrating sounders. Some years ago, when he was working with them, the question was not what you could work through, but what you could not work through. Major Cardew's key was, in his opinion, simpler than the one devised by Mr. Melhuish.

Mr. MORDEY said Mr. Preece had informed him that the dynamos at Deptford affected the telephones in Paris; if this were so, signalling across seas was already accomplished.

"The Diathermancy of Air in relation to the Efficiency of Incandescent Lamps," by F. HIGGINS, member. (Paper read April 10th, 1890.)

It is occasionally useful to know something of the state of the vacuum in incandescent lamps without injuring them by perforating the bulb with electric discharges.

The property which air possesses of transmitting radiant heat in proportion to its density, affords a means for obtaining this information.

I have not seen any mention of this property in works on the subject which I have consulted, and do not know whether my results agree with others which may have been obtained.

In order to make some comparative tests, I obtained, through the kindness of Major Flood Page, a number of lamp bulbs fitted with similar filaments of platinum iridium, as nearly as possible alike in length.

Some of these bulbs were exhausted to the highest possible degree, some left open to the air, and others exhausted to a pressure equal to $\frac{1}{10}$th inch of mercury.

With a sensitive thermoscope the different qualifications of the three descriptions can be made apparent.

The lamps of each class being very similar in their behaviour, it is only necessary to give the results obtained with one of each type.

The highest possible exhaustion is that which is supposed to be the condition of the electric lighting bulbs; the $\frac{1}{10}$th inch gives a vacuum like that necessary for the Geissler tubes; the air bulb, as before mentioned, open to the air.

By means of adjustable resistances and batteries the three lamps were brought to the same degree of red heat, as nearly as could be judged.

The potential at the filament terminals and the volume of current flowing were measured in each case, with the result that the air bulb required, to produce the red heat, 7·02 watts; the $\frac{1}{10}$th inch vacuum, 5·336 watts; and the highest possible, 0·646 watts only.

With the same lamps in series the highest possible becomes white hot with a current which scarcely causes visible redness in the air bulb filament, and only dull redness in the $\frac{1}{10}$th inch vacuum.

The relative conductibility of the three bulbs, as measured by radiation upon a sensitive thermoscope, was—

Air, 325°.
$\frac{1}{10}$th inch vacuum, 250°.
Highest possible, 35°.

When the same filaments were raised to incandescence, that in the air bulb required 31·2 watts per candle; the $\frac{1}{10}$th vacuum, 15·20 watts per candle; and the highest possible vacuum, 4 watts only per candle.

These results show that of two similar lamps one, merely from imperfect vacuum, may require double the current that is necessary in the other to produce the same amount of light, and at the same time become dangerously hot. The two extremes of my scale show, for example, the absorption of nearly eight times the force in the case of the air bulb that is necessary to produce the same effect in the most efficient lamp with a higher vacuum.

It is possible that vacua produced by chemical absorption of carbonic gas may be more perfect even than this, and advantageous to use. There is always some air left in a vacuum produced by a pump; but it is possible to imagine that no gas will be left unabsorbed in the case of caustic potash and carbonic acid gas being employed.

Lamps which differ much in the state of their surrounding medium differ also in their behaviour when current is applied. Those which have a very perfect vacuum attain incandescence slowly, and lose it in the same way, while those which are imperfect start suddenly into incandescence, and as suddenly lose it

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DISCUSSION.

General WEBBER asked Mr. Higgins if he proposed any means of testing the degree of exhaustion without using the methods ordinarily employed by lamp makers.

Major CARDEW enquired whether he had repeated his experiments with lamps having carbon filaments.

Mr. G. S. RAMM asked if his apparatus would indicate the difference between a vacuum of $\frac{1}{10}$th mm. and the most perfect obtainable. In his (Mr. Ramm's) opinion there was a great need of something to replace the ordinary coil test, which in the case of carbon lamps is unreliable.

Mr. GRANVILLE wished to know whether the thickness of the bulb made any difference in the efficiency, for he thought the heat conducting power of the glass must affect the temperature of the filament. He also asked if it would not be advisable to use double bulbs so as to have the benefit of the diathermancy of both.

The PRESIDENT said the well-known method of testing the state of the vacuum, by feeling at the bulb whilst the lamp is alight, was a fairly good guide. He thought the differences observed by the author were not due to diathermancy but rather to convection and diffusion.

Mr. HIGGINS, replying to Gen. Webber, said his apparatus had been used practically. In one case he received a lamp which was supposed to be exhausted to $\frac{1}{10}$th inch, but his thermoscope indicated a lower vacuum. On returning the lamp to the maker his prediction was verified. His apparatus was so sensitive that it gave a deflection of 600 divisions if touched with the finger. In answer to Major Cardew he said he had found the radiation from filaments of different materials to be alike. Referring to Mr. Granville's question he said he had not tried the effect of different thicknesses of glass, but he believed it better to use large bulbs rather than small ones. As to the cause of the phenomena observed, he once suspected that convection was operative, but, after investigating the matter, had concluded that it had no effect.

NEW PATENTS—1890.

4547. "Conducting telegraph, telephone, and other wires for electric lighting, &c., also pipes, tubes, &c., by means of oblong, square, or other suitably shaped blocks constructed in two halves, and having recesses, grooves, or perforations running longitudinally through them, into which the wires, tubes, &c., are to be laid. These blocks are adapted and constructed to take the place of the curb stones, and may be laid in crossings or other parts of roadways or other thoroughfares where they might be required." J. WILKINSON. Dated March 24.

4557. "Improvements in field-magnets and supporting frames for dynamo-electric machines." F. V. ANDERSEN and J. O. GIRDLESTONE. Dated March 24. (*Complete.*)

4605. "Improvements in electric switches." A. A. C. SWINTON. Dated March 25.

4648. "Improvements in the construction of dynamo-electric machines." P. F. DEGN. Dated March 25.

4650. "Improvements in means or apparatus for producing periodical or intermittent motion by electricity." H. B. PALMER. Dated March 25.

4657. "Improvements relating to the soldering or uniting of metals by electricity and to apparatus therefor." H. H. LAKE. (Communicated by E. Thomson, United States.) Dated March 25. (*Complete.*)

4660. "Improvements in devices for heating and cooking by means of electricity, including electric flat irons and other articles." H. R. BUTTERFIELD and W. MITCHELL. Dated March 25. (*Complete.*)

4745. "Improvements in apparatus for applying or directing electric currents from dynamo machines or like generators of electricity." A. ESSINGER and T. P. C. CRAMPTON. Dated March 26.

4767. "Improvements in electromotors and dynamos." J. V. SHERRIN. Dated March 26.

4791. "An improved instrument for measuring electrical currents." W. H. DOUGLAS. Dated March 27.

4821. "An improvement in insulated electric conductors." E. F. A. OBACH. Dated March 27.

4824. "Improvements in armatures for dynamo-electric machines." J. NEBEL. Dated March 27.

4846. "Multiplying the illuminating powers of electric lights." W. ANDREWS. Dated March 28.

4858. "Improvements in multipolar dynamo-electric machines." G. KAPP. Dated March 28.

4943. "Improvements in batteries for electrical purposes." W. BALCH and S. S. BROMHEAD. Dated March 29.

4972. "Improvements in arc lamps." R. KENNEDY. Dated March 31.

4973. "Improvements in dynamo-electric machinery." R. KENNEDY. Dated March 31.

4984. "Improvements in electric telegraph apparatus to transmit visible pointer indications corresponding to the movement of a transmitting handle." J. ROBINSON. Dated March 31.

4991. "Improvements in electric arc lamps." A. GAY and R. HAMMOND. Dated March 31.

4992. "Improvements in electric recording apparatus." A. GAY and R. HAMMOND. Dated March 31.

4993. "Improvements in electric heating apparatus." A. GAY and R. HAMMOND. Dated March 31.

4998. "Improvements in the manufacture of illuminants for electric lamps." H. G. NICHOLS. Dated March 31.

5008. "Improvements in electro-telephonic apparatus." E. F. FURTADO. Dated March 31.

5016. "Improvements in reversible machines suited for alternating electric currents." C. P. BABY. Dated March 31.

5049. "Means for effecting the sterilising of liquids by electricity." A. DE MERITENS. Dated April 1.

5054. "Improvements in the process of bleaching fibrous material by aid of electricity." C. KELLNER. Dated April 1.

5062. "Improvements in and relating to electric railways, and more especially to the overhead switches and overhead contacts." C. J. VAN DEPOELE. Dated April 1. (*Complete.*)

CORRESPONDENCE.

Far Distance Dynamo.

Misled by the diagram in Messrs. Bolling and Lowe's first letter, I thought that they were advocating the use of the second dynamo (F.D.) on a single circuit, where, for special reasons (as the utilisation of water-power), the dynamo had to be at a long distance from the lamps, motors, &c., it had to supply with current. Ony one pair of mains was shown with lamps across at one end and the two dynamos in series at the other.

As now shown in your issue of 11th inst., the working would, no doubt, as regards equalisation of pressure in the network of mains, be something very like perfection; but it would be a matter for determination in each individual case whether it was better to have a number of dynamos or to equalise the conductivity of the feeders by putting more copper into the long ones, or resistances into the short ones.

In any case, however, Messrs. Bolling and Lowe's system involves the use of more dynamos than are absolutely necessary. If it is decided that the several feeders shall be of different resistances, and, consequently, corresponding differences of E.M.F. are required, necessitating some sort of subdivision of the current generators, in place of the sweet simplicity of one or two large ones only, then one over-compounded dynamo of proper size to each feeder could supply the whole network of mains as steadily as one F.D. to each feeder, supplementing large constant potential generators. Also, the dynamos being all of moderate size, in the former case, the breakdown of one would be a small matter compared to the collapse of a large machine; and, further, the reserve plant would be on a much smaller scale and cause less capital to be lying idle.

If supplementary (or F.D.) dynamos are to be used at all, they might, I should think, be with advantage built on the "uni-polar" principle, thus saving the expense of commutators; the large current and small E.M.F. being just suited to this construction.

Unity is Strength.

April 14th, 1890.

Faulty Submarine Cables.

Suppose a submarine cable has a fault which does not prevent working but only lowers the speed a little, can it be proved that by joining up a good battery cell in the receiving circuit this will increase the resistance of the cable and thus improve the working capacity?

Tyne.

[The effect of the battery cell, supposing the copper pole to be connected to the cable, is to seal up the fault to a more or less extent; this is a well known fact, and has been taken advantage of in many cases where *small* faults have existed on cables.—EDS. ELEC. REV.]

Dynamo and Motor Design.

In reply to the letter which you published in last week's issue from "The Writer of the Abstract," please allow me to take exception to the "few words of explanation" which he offers.

In the "authorised abstract" the sentence occurs (the ELECTRICAL REVIEW, March 28th, page 363) "Laminating the cores has the effect of decreasing the divergence." What I said in my remarks is given in my letter published in your issue of April 4th, so I need not repeat it; but the sentence above quoted inaccurately represents half a statement. I think this kind of incompleteness is inadmissible even in an abstract.

Again, if the "Writer of the Abstract" will compare the corrected transcript of the verbatim report which was sent to me with the re-written copy, he will find that they are identical, and that the words of the verbatim report stand practically *en masse*. The statement therefore that I found it necessary to re-write my remarks is misleading in the sense in which it is used.

I would suggest that if a proof of the abstracts of discussions was sent to each speaker in addition to the verbatim report all difficulties of this kind would be avoided. Nobody wants to know what any speaker was *understood* to say. What he meant to convey alone can be of any value.

W. T. Sayers.

W. N.—We do not know whether there is any particular description of vulcanised fibre which effectually insulates, but our own experience bears out your experiments, and shows that except when kept perfectly dry it does not insulate well, but that it conducts by absorbing moisture.—EDS. ELEC. REV.